An Army Transforming While at War

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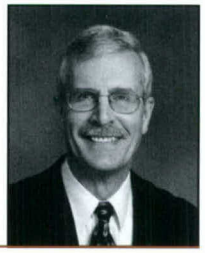
Message from the Director



Thomas L. McNaugher
Vice President, Army Research Division
Director, RAND Arroyo Center

What a difference a few years make—in this case to Army priorities. Three years ago, and notwithstanding the demands of the new and uncertain global war on terrorism, the Army was investing sizable amounts of money in long-term programs aimed at transforming the organization into a lighter, nimbler force. Today, those investments are being squeezed by the growing costs of current operations, most notably the war in Iraq. There is an almost whiplash-like quality to the speed with which present and future priorities have changed places.

Yet the Army has no choice but to continue transforming itself. It confronts too great an array of missions over too much of the globe to retain its former shape. And the fact is that it *is* transforming: witness the presence in Iraq of a Stryker brigade—a medium-weight force that did not exist just a few years ago.

Meanwhile, investments in the future continue, despite the press of current operations. Clearly, however, those investments must be screened and calibrated very carefully in the present fiscal environment. Presumably one major theme of the upcoming Quadrennial Defense Review (QDR) will be to find a new and sustainable balance of investment between current operations and future choices.

RAND Arroyo Center is committed to helping the Army transform while at war, and the essays in this Annual Report summarize streams of research that support that goal. We start where the Army always starts: with people. Soldiers remain the centerpiece of Army operations: the Army must continue to attract the number and type of soldiers it needs, even in today's stressful recruiting environment. Arroyo has worked with the Army for several years conducting two recruiting experiments designed to help the Army achieve both goals, and the first essay recounts the results of those efforts. Our second essay examines the challenge of training soldiers for the sophisticated operations of tomorrow's Unit of Action. It describes the new challenges training will pose, assesses the current efforts to deal with them, and suggests ways to overcome them.

The war in Iraq places demands on the Army's Reserve Components not seen in decades. A third essay analyzes the mobilization process used to call up these soldiers—the findings of a quick project launched in response to serious problems encountered in the run-up to Operation Iraqi Freedom. It concludes that the current system, designed to answer the needs of the Cold War, will not meet the requirements of the war on terrorism and must move from a "mobilize-train-deploy" model to a "train-mobilize-polish-deploy" one.

Once those soldiers have deployed they must be supported. Operation Iraqi Freedom rigorously tested the distribution-based logistics concept that supports our soldiers overseas and is also the model for transformation. Two essays in this Annual Report describe different aspects of that experience. One analyzes the performance of the Army war reserve stocks in supporting deployed forces, and a second describes the performance of the joint supply chain. While each system generally met the needs of the units in combat, problems cropped up in each area, and the essays sketch out ways to overcome them. Work on these projects has enabled us to help the Army resolve distribution problems for forces currently deployed, while also helping us shape a vision of what future logistics support should look like.

As the Army transforms to make its forces nimbler, of course, potential enemies can be expected to seek ways to deny those forces access to overseas areas. This is the

so-called "anti-access" problem that has seized the attention of those planning Army transformation. One of the essays included here explores what tools and tactics our enemies might employ to bar our access and suggests the elements of a strategy the United States might use to ensure access when our strategic interests come under attack.

Looking further to the future, another essay turns to what has been a consistent topic in the Army's transformation effort: operational maneuver through the air. The Army is considering the development of a "Future Transport Rotocraft" (FTR) that would move troops and 20-ton vehicles over operational distances on the battlefield. Given the array of air defense weaponry available to terrorists and other potential adversaries, FTR survivability is a major issue, and our next essay summarizes a recent Arroyo project on that issue. The analysis suggests that even a combination of active and passive aircraft defense technologies cannot necessarily guarantee the FTR's survival in a sophisticated but by no means implausible air defense environment. Advances in those technologies will have to be factored into the decision to develop this aircraft.

The war on terrorism has not only changed the nature of the threat, but it has also changed what is threatened, to include the U.S. homeland. Many organizations other than the Army have responsibility with respect to defending the homeland. The Army has always played a role, and the question today is whether, as part of its transformation, the Army wants to hedge against the risk of not being adequately prepared to respond to a domestic emergency. Our last essay sketches out some hedging steps that the Army—and the nation—might consider taking.

The war on terrorism will continue to tax the Army, as will its need to transform itself to meet tomorrow's challenges. RAND Arroyo Center is proud to join with the Army in coming to grips with these problems and looks forward to a continued opportunity to serve. ◆

The Arroyo Center: Origins and Growth

The Beginning: The Jet Propulsion Laboratory

The origins of RAND Arroyo Center trace back several years before its founding in 1982. Discussions about the Army's need for an external analysis agency had been going on since the mid-1970s among various members of the Army Staff, notably Lieutenant General Edward Meyer, then Deputy Chief of Staff for Operations, Dr. Walter La Berge, the Under Secretary of the Army, and Major General Maxwell Thurman, then head of the Army's Program Analysis Office and familiar with the support that RAND's Project AIR FORCE gave that service. Meyer became Chief of Staff in 1979, and in 1981 Thurman became the Army's Vice Chief. Along with James R. Ambrose, who became the Army's Under Secretary in 1981, they started the process that brought the Arroyo Center into being. All were familiar with the relationship between the U.S. Air Force and Project AIR FORCE at RAND and thought it would be a good model for the Army—an organization equipped with a range of analytic skills that could do independent and objective research on major Army issues. Credibility of research findings was crucial, and for that reason they concluded that the organization had to stand outside the Army. Hence they chose the management structure of Project AIR FORCE, namely that of a federal contract research center (later called a federally funded research and development center, or FFRDC).

The Army initially chose to locate its new analysis center at the Jet Propulsion Laboratory (JPL), located in the Arroyo Seco (literally, "dry river bed") just north of Pasadena, California. JPL had been founded as an Army laboratory. Although it had been transferred to the National Aeronautics and Space Administration when that agency was formed in response to the Soviet launch of Sputnik, the Army maintained a contract with the organization that could be readily expanded to include the new analysis center. Meanwhile, Mr. Ambrose's earlier experience in the aerospace field had made him familiar with JPL and its managing officials. Accordingly, an official from the Army Study Program Management Office approached the California Institute of Technology, which managed JPL for NASA, about establishing an analysis center patterned after Project AIR FORCE. This center was to be a high-quality, interdisciplinary research and analysis organization that would help the U.S. Army study long-range issues important to its civilian and military leadership.

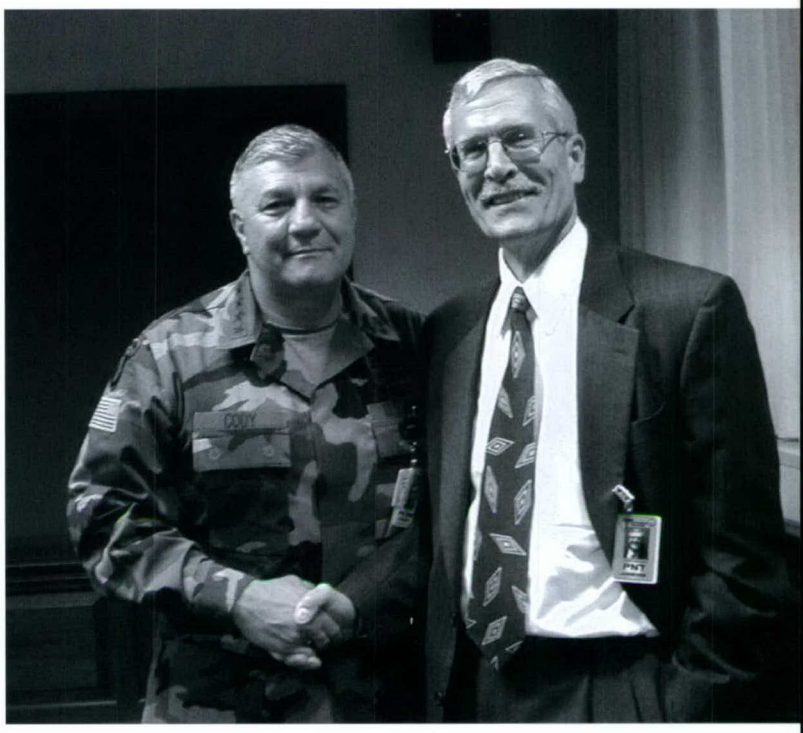
JPL formed a study group to consider the Army's request in May 1982. A series of discussions between Army officials, including Mr. Ambrose and Walter Hollis, the Deputy Under Secretary of the Army for Operations Research, and JPL and Caltech officials took place over the summer. The Caltech Board of Trustees approved the concept, and JPL appointed Dr. Martin Goldsmith as manager of what was initially called the Army Analysis Program. The new organization submitted its first annual operating plan to the Army's Study Program Management Office in September 1982. The plan addressed the proposed work for fiscal year 1983, which principally entailed organization and program definition but also authorized some limited substantive work. That document, coupled with the transfer of $200,000 to JPL, marked the beginning of what would come to be known as the Arroyo Center. In October, a committee under former JPL director William Pickering was assembled to establish a charter and mode of operation for the Army Analysis Program. In May 1983 the name was changed to the Arroyo Center, and the organization began reporting directly to the Director of JPL. The first director of the Arroyo Center, Richard

A. Montgomery, was hired in September 1983, replacing Martin Goldsmith.

From Arroyo Seco to Ocean Avenue

The Army's analytical goals and the philosophy of JPL's managing body, the California Institute of Technology, did not mesh well. Many Caltech faculty members believed that the new organization's policy focus was inappropriate for Caltech, whose expertise was primarily in technical fields. In spite of efforts on the part of Arroyo Center's and Caltech's leadership to allay such concerns, the faculty voted in January 1984 to have the university divest itself of the Arroyo Center. Army officials considered a number of alternative homes for the center, each deemed to have the requisite experience in operating an interdisciplinary research group. These included SRI International, the New Mexico State University Physical Science Laboratory, the Aerospace Corporation, and, of course, the RAND Corporation. In September 1984, the U.S. Army Chief of Staff decided to transfer the Arroyo Center to the RAND Corporation, and on February 1, 1985, the Arroyo Center facility at JPL closed its doors. During its tenure at JPL, the Arroyo Center published 27 reports on topics ranging from U.S. policy toward Latin America to the military uses of infrared sensors.

From a research perspective, the transition to RAND was relatively seamless. A handful of the 25 Arroyo researchers transferred from JPL to RAND, bringing with them three Army-approved research projects: Lessons Learned in the Field, Fault Lines in the Warsaw Pact, and Projection of Soviet Forces. Those three projects, coupled with five additional ones developed by the RAND staff, constituted the proposed research plan for 1985 that was presented to the Arroyo Center Policy Committee, the body formed by the Army leadership to oversee the Arroyo Center's research agenda. At the time, the committee had five members: the Vice Chief of Staff, U.S. Army, the Assistant Secretary of the Army (Research, Development and Acquisition), the Commanding General of U.S. Army Training and Doctrine Command, the Commanding General of Army Materiel Command, and the Deputy Chief of Staff, Operations. The Executive Agent for the Arroyo Center was the Director of the Study Program Management Office.



General Richard A. Cody, Vice Chief of Staff, U.S. Army, and Tom McNaugher, Director of RAND Arroyo Center.

The Early RAND Years

That first research agenda developed at RAND understandably reflected key Cold War concerns, notably how best to defend Europe against attack by Warsaw Pact forces. Yet it included the beginnings of research streams that continue to the present. One of the initial logistics projects, for example, employed the RAND Dyna-METRIC model, developed to analyze the movement of spare parts in Air Force maintenance systems, to help the Army find better ways to manage its spare parts. This work eventually grew into the Velocity Management project, which expanded the focus from spare parts to the entire supply and maintenance system and contributed to major changes in how the Army carries out its logistics. This particular project also illustrates the benefit of locating the Arroyo Center at RAND, where Army researchers could take advantage of the experience of their Project AIR FORCE colleagues, as well as colleagues in RAND's growing number of other research centers.

A second major stream of research appears in the work done at the Army's National Training Center (NTC) at Fort Irwin, California. One of the first questions the Army

In October 2004, Arroyo personnel took up residence in the RAND Corporation's new headquarters in Santa Monica, California.

asked Arroyo was whether scientifically valid quantitative research could be done in the field setting. The National Training Center collects an enormous amount of data on the mock battles fought there, but it was not clear whether that information would support valid research findings. Some early work indicated that it could, but that structured observations in the form of questionnaires from the observer/controllers, who accompany the units training there, could provide information not available from routine data collection. These techniques have been in use at the National Training Center ever since, and Arroyo Center researchers working there today employ the techniques developed in those early years.

The Post–Cold War Years

Even before the Berlin Wall came down, Arroyo Center researchers began helping the Army think about a future in which the main focus was not armored warfare on the plains of Europe. With forces of change clearly at work in the Soviet Union, anticipating what it might look like in five or ten years became important, and Arroyo researchers turned to such topics as contemporary events in the Soviet Union and the effect of Gorbachev's policies on the political scene. The withdrawal of the Soviet army and the reunification of Germany meant that the Army needed a new strategy to defend Europe. The Arroyo Center helped Army planners think about new strategies for Europe, while also focusing on new emerging national security needs that would require Army forces. Meanwhile, Arroyo's manpower experts helped the Army manage a near-40 percent reduction in strength that began in 1992.

But it was also clear that the United States was destined to play a much different global role, so the Arroyo Center broadened its focus to take in other arenas and types of conflict, including conflicts in the Third World. Some saw Operation Just Cause, which drove the Noriega regime from power in Panama, as a harbinger of other regional contingencies, and Arroyo Center researchers analyzed that operation to determine what it might imply for supporting similar operations. Operations other than war (OOTW) had always been in the Army's repertoire, but they assumed new importance following the Cold War; indeed, some saw them as the Army's primary role and argued for a drastically revamped force structure to deal with them. While recommending against that approach, Arroyo Center researchers nonetheless explored the ramifications of OOTW, particularly their effect on preparedness for traditional military missions.

As the post–Cold War decade wore on, the Arroyo Center devoted considerable effort to helping the Army resolve two persistent dilemmas. One was created by small but repetitive deployments that seemed to have a disproportionately large effect on the Army's operating tempo and readiness. Arroyo Center research helped the Army understand the complex effects of small deployments and how they might best be managed. The second dilemma was created by what some have called the "barbell" shape of U.S. forces: very capable but heavy forces unable to deploy quickly, and agile light forces able to get to the area of conflict rapidly but lacking punch and staying power. Well before the Army launched its ambitious "transformation" effort in the fall of 1999, Arroyo had begun to suggest ways for the Army to make the light forces more effective without robbing them of their agility.

Arroyo Today

For the nation as a whole, and certainly for the Army, the world changed on September 11, 2001: for the first time

in half a century, the United States suffered an attack on its home ground launched not by a nation, but by an elusive and murky foe. The nation's initial response, the destruction of the Taliban regime and the scattering of the remains of al Qaeda, is a matter of history. But the threat has not and in all likelihood will not go away for the foreseeable future. Thus, the task facing the Arroyo Center is to help the Army come to grips with what might arguably be characterized as the most demanding period of its history. It is in the middle of fighting a new type of war on global terrorism. Afghanistan represented only one form that this new type of conflict could assume. So the Army must simultaneously fight the war, divine what other forms it might take, and prepare for those as well.

While the global war on terrorism continues, the war in Iraq has taken center stage and in doing so has spawned a whole host of research issues. The combat phase is receiving its due share of analytic attention, but many other issues clamor for analysis. The logistical system did not perform in the way that many expected, and Arroyo is working with the Army to identify what went wrong and ways to fix it. The Army has taken more casualties trying to stabilize the country than it did in defeating the Iraqi army, and it has become clear that the war has entered a new, more deadly phase. Arroyo is attempting to gain insight into the nature of the current insurgency and its unique mode of operation. The heavy use of reserve components underscores the need to re-examine the balance between the components. Even the most optimistic estimates suggest that forces will remain in Afghanistan and Iraq for several years, which means successive rotations of troops through those theaters. Arroyo is working with the Army to identify ways to increase unit stability and determine whether doing so will achieve the Army's goals. And of course the intense combat operations have not slowed the Army's efforts to transform itself from an armor-heavy Cold War force to a lighter, more agile, and more technologically sophisticated one that still retains the ability to take on tank-heavy forces. Any one of these challenges would be formidable. In combination, they could be overwhelming, and they demand the best efforts of the Army and the Arroyo Center to meet them.

The Army's need for first-rate research has never been greater. Over the past two decades, the Arroyo Center has recruited the research staff, developed the analytic tools, and created the research capital to meet this need, and it looks forward to many more years of helping the Army serve the nation. ◆

The Arroyo Center Policy Committee

RAND Arroyo Center benefits from the oversight and guidance of an important group of senior Army leaders, known officially as the Arroyo Center Policy Committee (ACPC). Its guidance transcends individual projects that address issues of immediate concern to the Army to focus on the development of major lines of research critical to the Army's long-term effectiveness. The ACPC plays an indispensable role in motivating the Army and RAND Arroyo Center to initiate research on the fundamental policy questions that cut across jurisdictional boundaries within the Army and the overall defense community. Its membership comprises the following individuals.

General Richard A. Cody (Co-chair)
Vice Chief of Staff, U.S. Army

Mr. Claude M. Bolton, Jr. (Co-chair)
Assistant Secretary of the Army (Acquisition, Logistics and Technology)

Mr. Reginald J. Brown
Assistant Secretary of the Army (Manpower and Reserve Affairs)

Mr. Walter W. Hollis
Deputy Under Secretary of the Army (Operations Research)

General Kevin P. Byrnes
Commanding General, U.S. Army Training and Doctrine Command

General Benjamin S. Griffin
Commanding General, U.S. Army Materiel Command

General Dan K. McNeill
Commanding General, U.S. Army Forces Command

Lieutenant General Philip R. Kensinger, Jr.
Commanding General, U.S. Army Special Operations Command

Lieutenant General Kevin C. Kiley
Commanding General, U.S. Army Medical Command/ The Surgeon General

Lieutenant General Franklin L. Hagenbeck
Deputy Chief of Staff, G-1, U.S. Army

Lieutenant General Keith B. Alexander
Deputy Chief of Staff, G-2, U.S. Army

Lieutenant General James J. Lovelace
Deputy Chief of Staff, G-3, U.S. Army

Lieutenant General Claude V. Christianson
Deputy Chief of Staff, G-4, U.S. Army

Lieutenant General Steven W. Boutelle
Chief Information Officer/G-6, U.S. Army

Lieutenant General David F. Melcher
Deputy Chief of Staff, G-8, U.S. Army

Major General Larry J. Lust
Assistant Chief of Staff for Installation Management, U.S. Army

Executive Agent for the Arroyo Center
Major General Ross N. Thompson, III
Director, Program Analysis and Evaluation, Office of the Deputy Chief of Staff, G-8, U.S. Army

Filling the Ranks

Recruits in basic training meet with Sergeant Major of the Army.

It is unclear how tours in Iraq and Afghanistan—sometimes repeated ones—will affect recruiting or retention. But it is manifestly clear that recruiting is crucial to the success of today's all-volunteer force, and both civilian and military policymakers remain committed to the volunteer concept. Recruiting is not simply a matter of numbers; quality matters. Today, soldiers must know how to operate and care for an array of increasingly sophisticated equipment. More important, they must operate in ambiguous situations that do not lend themselves to formulaic responses. They must think and adapt on the fly. Attracting and keeping such soldiers is no small challenge.

During the late 1990s, the services had serious recruiting challenges. In response, they increased recruiting resources substantially. Still, the services struggled to enlist enough soldiers to fill their ranks. In addition to a strong economy, a growing proportion of youth were continuing their education upon graduation from high school; the percentage rose from one-half to two-thirds between the early 1980s and late 1990s. This posed a challenge to military recruiting, which traditionally has focused on the recruitment of youth when they graduate from high school. Today, many youth who aspire to two- or four-year degrees are unwilling to postpone their education to serve in the active-duty military. Thus, the Army faces both near- and long-term challenges in attracting highly qualified youth and must do better in recruiting from this group if it is to continue filling its ranks.

The services also face a cap of 10 percent on enlistment among youth who do not graduate from high school. The Office of the Secretary of Defense (OSD) imposes this cap in light of the greater loss rate during the first term of service among such recruits. Even so, today such youth make up approximately 20 percent of the U.S. youth population and disproportionately come from minority groups. Thus, the cap has implications for both overall enlisted supply and equality of opportunity.

Two Programs

To address these challenges, RAND Arroyo Center helped the Army develop two pilot programs and designed a national recruiting test to evaluate their performance. Patterned after earlier RAND recruiting tests, the experiment offered contrasting programs across matched sets of geographic areas, enabling rigorous assessments of program effects. The programs, College First and GED Plus, were initiated in February 2000.

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Significantly, market expansion effects grew during the course of the experiment, with more than 13 percent additional high-quality contracts obtained by the fourth test year.

College First

Under the National Defense Authorization Act of FY00, the College First pilot program extended through the end of FY04. College First targets youth interested in attending two-year colleges or vocational schools before entering the Army. The focus on those going to two-year colleges or vocational schools reflects results from research by RAND as well as others, including the U.S. Army Recruiting Command, which indicated that the two-year college market was potentially a very good one for military recruiting in terms of both the potential interest of the youth in that market in serving in the military and their ability to meet the qualification requirements for service. The program offers several incentives. It helps cover school costs by paying a stipend and offering eligibility for college loan repayment. Those who earn an associate degree receive a cash bonus and the rank of E4 upon entry to active duty in recognition of their greater wage-earning power.

GED Plus

The second program, GED Plus, was initiated in February 2000 by agreement with OSD and ran through February 2004. GED Plus aimed for immediate improvement in the Army's recruiting picture. It targeted high-aptitude youth lacking a traditional high school diploma, sponsoring participants to obtain GED credentials, if needed, before entering active duty. To minimize future attrition, these youth are screened on relevant criteria.

Those who enlisted through the GED Plus program went through more extensive screening than the average recruit. First, all recruits into GED Plus had to be in the upper half of the written aptitude distribution, that is, they had to score in categories I–IIIA on the Armed Forces Qualification Test.[1] Second, recruits had to score in the upper 75 percent on the Assessment of Individual Motivation (AIM) test. The Army Research Institute developed this test, which identifies a bottom quartile of recruits with much higher prospective loss rates in the first term than recruits with better scores. Third, eligibility for the program was restricted to nongraduates who left high school by their own choice—that is, were not thrown out of school—and who were now too old to return. Finally, few moral or drug/alcohol waivers could be granted under the program.

In selected areas, GED Plus offers qualified youth the same enlistment incentives available to recruits holding traditional high school diplomas. This provision was tested because in the recent, difficult recruiting market, the Army had trouble recruiting the allotted 10 percent of GEDs from categories I–IIIA of the Armed Forces Qualification Test.

Both programs were tested in matched sets of test sites (recruiting battalions) across the United States. One set offered the program, and its counterpart sites did not. Arroyo balanced the characteristics of the test and control areas for each program on a variety of factors that are known to affect recruiting production: geography, demography, economics, and education. Also taken into account were recruiting characteristics (e.g., recruiting goals and actual production) of the area and the amount of National Guard funding for education that is available.

Results

The results for the College First program are encouraging: College First expands the number of high-quality enlistment contracts significantly—these are youth with high school diplomas who score in the upper half of the written aptitude distribution on the Armed Forces Qualification Test. Significantly, market expansion effects grew during the course of the experiment, with more than 13 percent additional high-quality contracts obtained by the fourth

[1] The Armed Forces Qualification Test predicts an individual's ability to complete military training and perform well in his or her military occupational specialty. Scores place an individual into one of five categories (I through V); those in categories I–IIIA are considered to be high-aptitude recruits who are more likely to perform well in the military.

test year. Expansion was greatest among the two fastest-growing subgroups of the youth population: Hispanics and other non-African American minorities. Moreover, a more intense focus on high school seniors is likely to yield even more significant benefits. Both overall and for the College First program, seniors represent a large potential market, one that national surveys indicate has a greater interest in joining the Army than other market segments. Assigning recruiting areas specific missions to recruit high school seniors via the College First program could yield positive results.

The GED Plus program significantly expands high-aptitude enlistments among youth without traditional high school diplomas. The basic-incentives version of the program produces about half the expansion of the enhanced-incentives version—about 10 percent and 20 percent, respectively, across the four test years—but at a much lower cost per contract. As is true for College First, expansion is especially large among Hispanic youth. In the case of College First, this is probably due to the substantial interest of this subgroup in two-year colleges. For GED Plus, it is probably due to the overrepresentation of Hispanic youth among high school dropouts. While market expansion during the test under GED Plus was significant, it is likely to increase even more by setting high-aptitude recruit missions specifically for youth with high school diplomas and for those without traditional high school diplomas. This step would prevent substitution across graduation categories in meeting the Army's high-aptitude recruit goal—there was some limited evidence of possible substitution during the test—thereby encouraging recruiters to leverage the GED Plus program to help produce high-aptitude contracts in both markets.

We found that the current screening mechanisms for GED Plus eligibility did not significantly reduce loss rates for GED Plus enlistees below those of other recruits with a GED. This results primarily from the fact that, under the current scoring algorithm for the AIM test, very few applicants fail. Since few recruits are screened out, the enlistees' first-term loss rate closely resembles that of other soldiers with similar characteristics. However, it is also true that there was only a modest relationship between the AIM score under the GED Plus test and subsequent failure rates; this means that simply raising the cut score is inadequate to produce the desired effect. The Army is in the process of dealing with this problem by modifying the scoring algorithm and investigating supplemental screening measures.

Such issues notwithstanding, both programs have proven to be successful. Not only are they helping the Army meet its recruiting needs in terms of overall numbers, but they are also bringing in the type of soldiers the Army needs in the future. ◆

Developing Effective Training Strategies for the Unit of Action

The need for well-trained soldiers and leaders is never so apparent as when the Army is at war; at the same time, the necessary focus on deployment and support to deployed units during wartime means that the time and resources available for training can become ever more scarce. The Army currently faces challenges like these, intensified by the need to adapt training to meet the demands of the transforming Army. RAND Arroyo Center is conducting research to help the Army develop new approaches to support training for the Brigade Combat Team Units of Action (BCT UAs), which are currently being formed, and Future Combat Systems (FCS) UAs, which are expected to form in the future. This research seeks to provide a broad perspective on challenges and potential improvements with regard to key training concepts. The Army is forming BCT UAs by converting current units into more deployable, self-sufficient, brigade-sized elements. The FCS UA will take the same concepts—centered on survivability, increased lethality, deployability, and self-sustainability—and apply them using more and more sophisticated technologies. This means evolving tactics, techniques, and procedures—and thus training—to get the best advantage from the evolving technologies.

Both BCT UAs and FCS UAs will face challenges different from and more complex than those Army forces have experienced in the recent past. Given the current geopolitical environment, frequent deployments involving rapid mission changes are likely to continue.

Both BCT UAs and FCS UAs will face challenges different from and more complex than those Army forces have experienced in the recent past. Given the current geopolitical environment, frequent deployments involving rapid mission changes are likely to continue. The Army can also expect to see greater use of joint and combined arms operations at lower echelons, an expanded range of missions, and a continuing evolution of methods, force structure, and technology in response to an adaptive enemy.

These changes have important implications for the Army's training strategies. For the Army to realize the full benefits of a modular, self-sufficient, and networked force, its training will need to enhance soldier and leader capabilities in many skill areas, including command and control, synchronizing operations, employing precision fires, and protecting command posts and sustainment elements. Training will also have to address a wider range of skills and a greater range of scenarios than it has in the past, and yet remain adaptable, i.e., easy to modify even for units deploying or already deployed.

UA Training Is Likely to Pose Greater Challenges

To understand how future operational training strategies will need to change to support the UA, Arroyo researchers first assessed the potential of the current training strategy, with proposed enhancements, to meet UA needs. Units participate in operational training at both home station

and centralized facilities, including the Army's combat training centers (CTCs), such as the National Training Center (NTC) at Fort Irwin, California. The CTCs provide training in an environment that tries to match combat as realistically as possible. Home station training includes live training on a smaller scale as well as virtual and constructive training events using three-dimensional and two-dimensional imagery and displays to simulate combat.

Arroyo researchers analyzed the performance of units at the NTC and found that although many units perform most critical tasks adequately at some point during the NTC rotation, they typically require an entire rotation to reach proficiency. Moreover, performance in some skill areas that may prove significant for UAs, including synchronization and combined arms integration, often does not reach adequate levels.

Researchers also analyzed the content of FY01–02 battalion training programs. This research indicates that units were not doing enough training to achieve UA training goals. For example, data from FY02 (see Figure 1, which illustrates our findings on tank battalions) show that units did only about half the number of live maneuver events and about 40 percent of simulation events recommended in the Combined Arms Training Strategy (CATS). In addition, these units conducted higher-echelon training events (company and above) only when they were preparing to go to the NTC, raising questions about the sustainment of NTC-achieved readiness between rotations. We also learned that light battalions did almost no simulation exercises.

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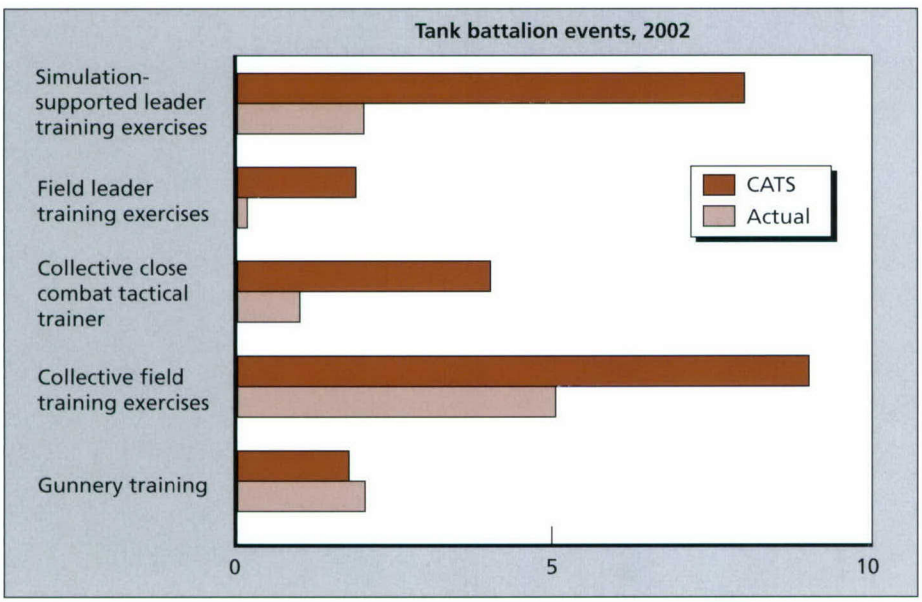
Today's training programs appear to be even more restricted, because units must focus on specific missions relevant to current deployments rather than train in the full range of skills. Among the major reasons cited for the reduced number of training events conducted were limited time and resources. Unit leaders and key staff from the 3rd Infantry Division, 1/25th SBCT,[2] 4th Infantry Division, and III Corps reported that the most significant

[2] The SBCT is a brigade combat team equipped with the Stryker armored vehicle.

Figure 1. Units are Implementing Fewer Events Than Recommended by CATS



Soldiers from a Stryker Brigade on patrol in Iraq.

time constraints included the need to prepare for training events and to address other demands, including support for ongoing deployments. They also said that constructive simulations did not do much to train complex skills and took extensive unit effort to prepare and execute.

Proposed Enhancements to Training Can Help, But May Not Be Sufficient by 2014

Arroyo researchers found that while these enhancements will help, they might not be sufficient in themselves to meet FCS UA needs by 2014. For example, a key enhancement proposed by the training community is embedded training (ET), which refers to training that is integrated within Army weapon systems, enabling soldiers to train anytime and anywhere, and to incorporate "live" data.

The Army will need to pay close attention to the effects of unit-focused stabilization as it is implemented, with a special view toward the effects on collective training proficiency at all affected echelons.

Although ET will most likely become a cornerstone of operational training over the long term, key components will not be fully available by 2014, nor will ET be available to cover all situations (e.g., operations involving dismounted infantry). ET will only be as effective as the underlying virtual and constructive technologies and distance-learning capabilities, which are not expected to be advanced enough by 2014. While the realism of simulations will improve over the next decade, artificial intelligence capabilities will probably not be sufficiently advanced to portray the full range of situations and human behaviors that soldiers might face on the battlefield.

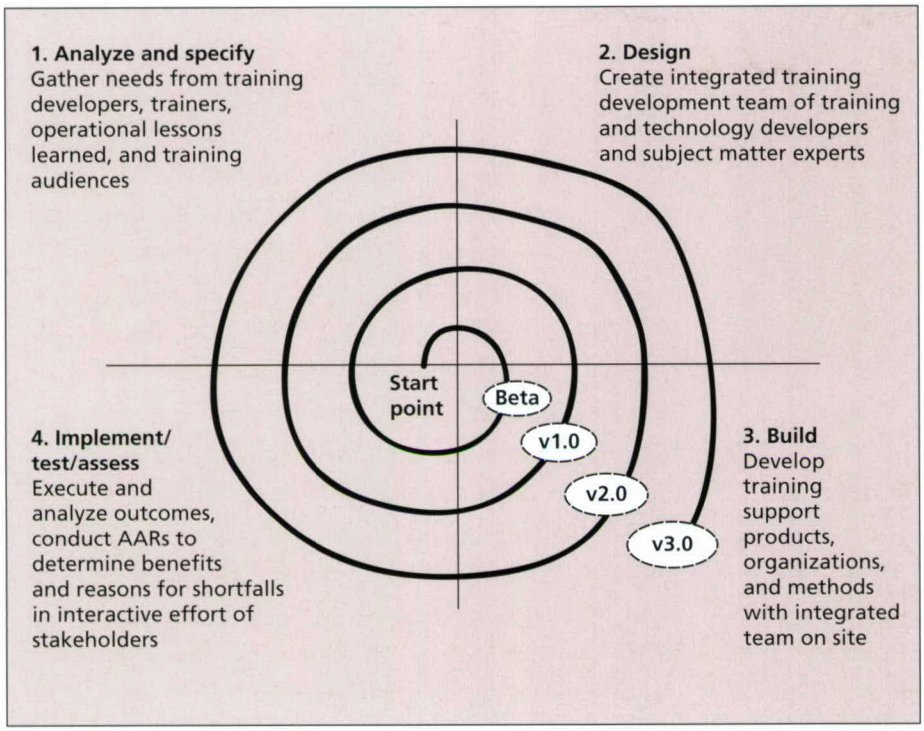
Other proposed enhancements, including improvements to CATS and additional training support packages (which provide direction on how units should execute specific training events), can improve training quality. Many of these products are little used now; they will have more potential if they can provide the kind of adaptable support that units indicate they need.

Army plans to stabilize personnel may prove more beneficial. Such stabilization might reduce the need for unit sustainment training and possibly raise the overall level of proficiency that can be sustained. The Army will need to pay close attention to the effects of unit-focused stabilization as it is implemented, with a special view toward the effects on collective training proficiency at all affected echelons.

An Evolutionary Approach to Developing a New Training Strategy

While individual enhancements to training can help address the evolving needs of the BCT UA and FCS UA, Arroyo's research emphasizes the need for the Army to go beyond individual "point solutions" and instead develop a training strategy that can evolve. An adaptation of the spiral development concept represents such an approach. As indicated by Figure 2, spiral development provides a means to design, build, implement, and test training products and approaches as part of a cycle of continuous improvement. Through this process, the Army can take advantage of the learning opportunities provided by the current operating environment and modernization efforts to evaluate and modify training products and approaches on an ongoing basis.

Figure 2. Spiral Development of Training Is a Process of Planned Evolution



Spiral Development Can Be Used to Support Improvements to Simulation-Based Training

Spiral development can help the Army more quickly capitalize on the benefits of new technologies for simulation-based training and adapt these technologies to increase the benefits even further. In the near term, spiral development might be used to develop a global web-based library of training materials (e.g., training plans, simulation scenarios) that could be shared across units and adapted as needed. This process could be started immediately with low-cost experiments and development projects to gain understanding of how training materials can be better designed for reuse and to create incentives for sharing training content.

Over the longer term, spiral development might also be used to improve the realism of simulation-based training tools, including their ability to represent friendly and enemy forces engaged in complex planning and collaboration activities. The process might begin with a focus on improving the simulation of simple, individual behaviors. Over time, the Army could seek to leverage commercial game methods while supporting both applied and longer-term theoretical research to understand and model both individual and group behaviors in operational settings. Improvements in simulations' ability to train complex skills can be evaluated by comparing simulation-generated outcomes with those of live training and operations.

Increased Training Support Capabilities Will Probably Be Needed to Meet FCS UA Training Goals

Spiral development might also be used to assess options for providing improved training support manpower to units. Because many of the training simulation technologies will require years to develop, more traditional forms of training support, like dedicated manpower, will remain critical to making training work; moreover, the emerging training requirements being proposed for the UA will require a greater degree of support than does today's approach. The concept calls for intense ramp-up training over six months, a shorter period than the one currently used by units to prepare for a CTC rotation. In this part of the cycle, training support personnel will, for example, perform as observer/controllers (who provide structure and feedback) and opposing forces during collective training events. A period of sustaining proficiency will follow the ramp-up period. Here trainers will be needed to provide such support as sustaining

Spiral development can help the Army more quickly capitalize on the benefits of new technologies for simulation-based training and adapt these technologies to increase the benefits even further.

While it is clear that increased training support is necessary to meet strategic requirements and to achieve UA operational concepts, many questions remain about the size, functions, and locations of future training support organizations.

digital skills and improving on tasks not trained to full proficiency during the ramp-up. Finally, because fast deployments could allow little time for preparation, personnel to provide surge support and in-theater training support (or reach-back) will probably also be needed. In addition, support personnel can establish a fully effective lessons-learned program to facilitate training for follow-on units.

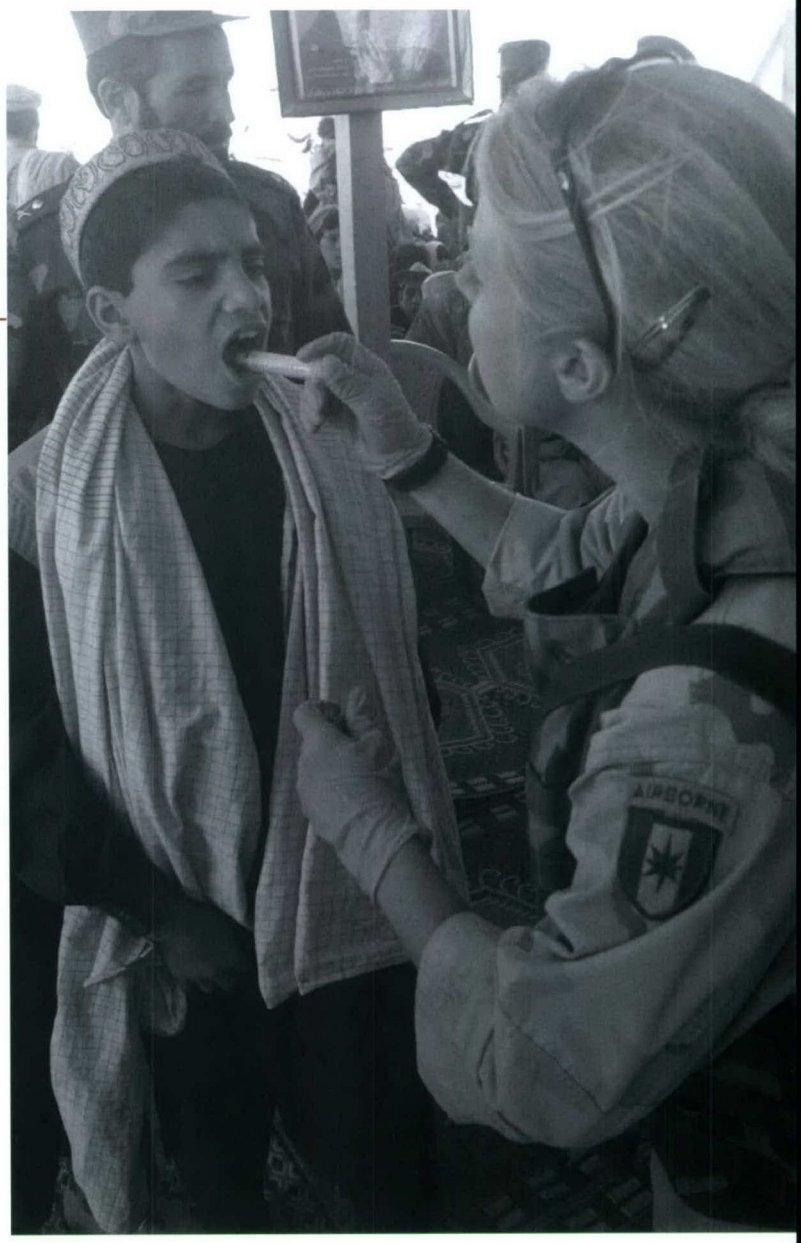
While it is clear that increased training support is necessary to meet strategic requirements and to achieve UA operational concepts, many questions remain about the size, functions, and locations of future training support organizations. A combination of local and centralized training support will most likely be required. Local training support organizations could support "reach-back" training during deployments, conduct operator and leader training, and identify and disseminate lessons learned. Training support personnel might also help improve simulations by assisting in the development of hardware, software, and methods, and by helping assimilate technological change. A centralized training organization could coordinate the additional support needed to meet surge requirements, particularly during initial training ramp-up and preparation for deployment.

The centralized training support system could also see to the consolidation of lessons learned and the preparation of the next generation of training support products—again along the lines of the spiral development concept. Spiral development can be used to test and assess various training support options. For example, the process might be used to develop and test an achievable prototype local training organization (supported by the centralized organization) to conduct modular BCT ramp-up training. Spiral development might also be used to assess which kinds of training might be provided through distributed learning, which courses might be provided through training institutions, or the optimum mix between CTC and home-station training to achieve the highest level of proficiency possible.

Ongoing Research

Continuing research at RAND Arroyo Center is examining how the UA training strategy might evolve. This research is seeking to determine how the concepts of stabilization, modularization, and digitization should help the Army to evolve and adapt the training strategy for the BCT UA. The study is also looking at how and when training for the FCS UA can incorporate training concepts that leverage the advantages that will be proffered by FCS UA technologies. ◆

Mobilizing the Force



Reserve Component soldier giving immunizations in Afghanistan.

In the early 1970s, the U.S. Army restructured its forces so that large-scale conflicts would require calling up reserve component units. As a result, preparations for Operation Iraqi Freedom (OIF) implied a major mobilization of Army reserves. Most of the mobilizations of Army reserve component capabilities did not occur until the period of December 2002–February 2003, at least in part because of the administration's decision to delay major force mobilizations and movements until diplomatic attempts to resolve issues with Iraq had been exhausted. Consequently, the time available for the largest mobilization since the 1991 Gulf War was compressed, which placed unusual stress on the mobilization system as well as the units that were mobilized.

Although Army mobilization doctrine and processes were designed to conduct mobilizations for large-scale conflicts like OIF, the way OIF mobilizations came about did not match the Army's expectations and hence required adaptations. This article describes how the mobilization system performed in calling up forces for OIF and offers some suggestions about how to improve it.

Mobilization Processes for Iraqi Freedom

The OIF mobilization drew on a Cold War mobilization system that erroneously assumed predictability; doctrine and training reinforced this assumption. In the 1990s, a unit-oriented, linear timeline model that reflected a "mobilize-train-deploy" concept characterized the Army mobilization process.

Before mobilization, reserve units normally train for their assigned mobilization mission and are generally limited to 39 training days a year. The mobilization process begins with an alert period designed to give individual reservists time to arrange their personal affairs. Unit leaders use the alert period to identify problems that must be dealt with as the unit mobilizes and prepares for deployment. Units called to active federal service mobilize at their home station and, after a short period, move as a unit to a mobilization station, where they ensure that personnel and equipment meet deployment standards and carry out individual and unit training. The postmobilization process is complete once the mobilization station validates the unit's readiness to perform the tasks that the theater or task force commander expects of it.

Alerting, mobilizing, operating mobilization stations, and moving forces to ports involved at least 11 automated joint and Army information systems, not counting readiness reporting.

The mobilization plans and processes in place at the time of OIF were quite complex. At least 14 organizations were involved in commanding and directing Army reserve components in peacetime. The postmobilization task organization could not be anticipated, since planners assumed it would be implemented incrementally depending on circumstances. Ten Army organizations were expected to publish various alert and mobilization orders. Alerting, mobilizing, operating mobilization stations, and moving forces to ports involved at least 11 automated joint and Army information systems, not counting readiness reporting.

The result was a complex bureaucracy in which preparedness for mobilization was seldom anyone's highest-priority task. Automated information systems were often unable to pass information among the agencies involved. Accountability for mobilization performance spread across multiple agencies. It was against this backdrop that mobilization for the war on Iraq began.

Since September 11, the Army's mobilization process has been used for a purpose it was not designed to serve. The war on terrorism was nothing like a major regional contingency. There was no preplanned mission or time-phased database for deployment operations. Requirements often called for only parts of units. Units that expected to be called early were not called at all; other units that expected to have many weeks of notice found that they had only days to prepare for mobilization. Although OIF fit the template for a major contingency and a time-phased deployment plan had been developed, it was not used to prioritize and coordinate deployments.

Three root causes account for the various stresses these differences created. First, force and mobilization planning had not caught up with the implications of the end of the Cold War and remained focused on large-scale conflict. Second, the global war on terrorism places a heavy demand on support capabilities that are largely in the reserve component where, by design, readiness levels are low. Third, centralized management and outdated, incompatible information systems hampered mobilization operations.

Since September 11, more than 216,000 reserve component soldiers have been activated, about 62 percent from the National Guard and 38 percent from the U.S. Army Reserve.[3] Demand for reserve component forces surged three times: once in October 2001 for homeland security, force protection, and operations in Afghanistan; again between January and March 2003, mainly for OIF but also for Afghanistan; and finally from October 2003 through January 2004, for troop rotations to Iraq and Afghanistan.

Mobilization from September 11, 2001 through the end of 2002 had implications for the subsequent OIF mobilizations. These mobilizations reduced the pool of units available to support OIF. Moreover, cross leveling and the mobilization of parts of units in 2002 began to erode the readiness of the remaining pool of Army reserve component units.

Forces Command (FORSCOM) wanted to initiate the call-up of necessary mobilization support capabilities in October and November 2002. But the Office of the Secretary of Defense (OSD) did not approve the proposed force. Eventually, mobilization of some 17,000 support personnel was approved. However, the orders to mobilize the forces for OIF and the 17,000 mobilization supporters were essentially concurrent. As a result, forces and mobilization supporters began arriving at mobilization stations simultaneously, rather than sequentially as Army mobilization planners envisioned.

Forces for OIF were ordered up through a process using Requests for Forces (RFFs). Though similar processes had been used in the 1990s to identify and deploy both special and conventional forces to the Balkans and elsewhere, the process was not embedded in Army or Joint

[3] Mobilizations required about 38 percent of the total pool of Army National Guardsmen in the selected reserve pool and about 40 percent of Army Reserve soldiers in the selected reserve.

doctrine and training. As a result, most soldiers expected that forces would deploy in accordance with a detailed time-phased deployment plan. When that did not happen, expectations created in the 1990s were disappointed, problems occurred, and the RFF process was criticized.

Both formal and informal processes influenced the RFFs. They were formally initiated by joint task force commanders, staffed through Central Command (CENTCOM) headquarters, sent to the Joint Staff and the Secretary of Defense for review and approval, and implemented by deployment orders. The result was an unsystematic, sequential statement of requirements. The informal processes resulted in a "heads up" to FORSCOM as soon as an RFF was created, and FORSCOM passed the word on to key Army mobilization process participants. This warning helped anticipate needed actions but also created problems. For one, many RFFs were not approved as submitted, so some of these efforts to lean forward proved unnecessary. Second, the time to process the RFF varied considerably, so it was difficult to estimate just when specific reserve units in an RFF would be needed.

Processing times for RFFs varied widely. For example, in January 2003, the average period for RFF approvals was about 30 days, with the longest taking 74 days and the shortest 9 days. Many explanations have been advanced for the variation in approval times, including the size of the force to be deployed, the time spent on reviews within CENTCOM, and the number of reservists to be called up. But statistical analysis shows no correlation between the size of Army forces included in an RFF and the length of approval time. Similarly, extensive review within CENTCOM did not shorten Pentagon approval processes; the data show that longer CENTCOM preparation times correlated with longer Pentagon approval times. Proximity to combat appears to have the most consistent effect. As war approached, RFFs were approved more rapidly.

Mobilization Performance During Iraqi Freedom

The Army's linear mobilization process can be divided into four steps. First, a unit is alerted about an impending mobilization. Second, it receives a formal mobilization order, which directs the unit to assemble at its home station and be mobilized for active duty on a specific date.

These standards imply that Army reserve component combat service support company or smaller units need about 90 days lead time if they are to deploy for combat operations.

Third, it moves to a mobilization station, usually three or four days after its mobilization date. At the mobilization station, the unit and the mobilization station prepare the unit's equipment for deployment, gauge the readiness of the individual soldiers, and train the unit in collective operations. When all this is completed to standards set by the requesting combatant commander, the unit is validated for deployment, completing the fourth step.

Drawing from various sources, it is possible to derive standards for each segment of the mobilization process. These appear in Table 1. Allotted times have been calculated for combat support and combat service support units, since these were the types of units mobilized for OIF. The data indicate that it ought to take between 83 and 96 days to mobilize these kinds of units.

These standards imply that Army reserve component combat service support company or smaller units need about 90 days lead time if they are to deploy for combat operations. If estimated times required to transport the units to distant theaters are added, the time needed grows

Table 1. Mobilization Time Standards for Small Support Force Units

Step	Days Allotted
Alert to mobilization order	30
Mobilization order date to mobilization date	30
Mobilization to mobilization station arrival	4
Mobilization station arrival to validation	19–32
Total	**83–96**

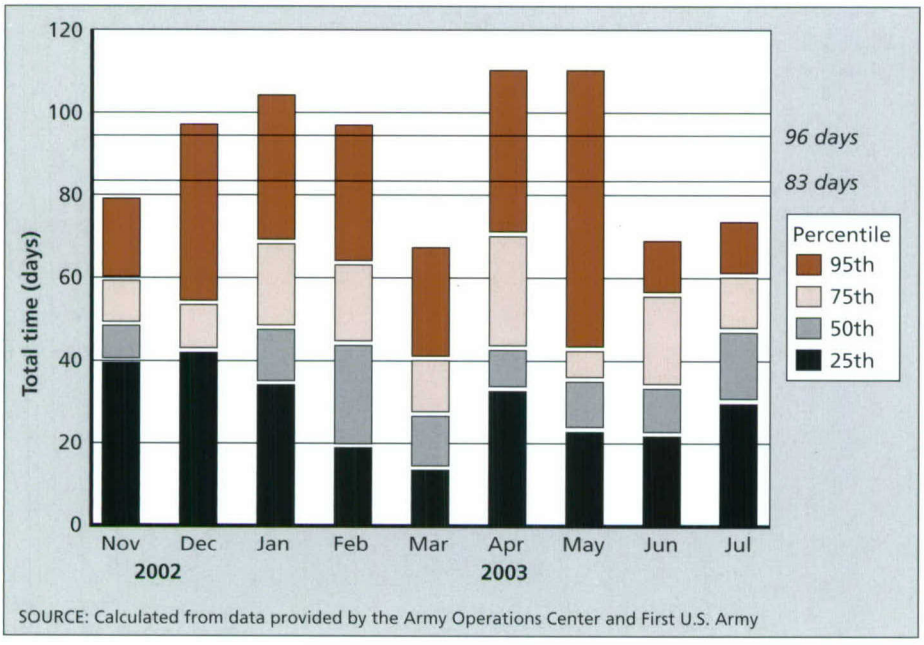
The fact that the mobilization system generally met expected standards does not mean that problems did not occur.

to 100 to 120 days. The RFF process seldom gives such lengthy lead times.

Figure 3 depicts the performance of the mobilization system. It estimates the total time required by tracking specific units through the entire process from alert message to validation. It presents the data by percentile, accounting for the mobilization time (alert to validation) of 95 percent of the units called up.

Given this set of standards, overall Army mobilization performance for OIF generally met or bettered both standards. In four of the nine months examined, 95 percent of the units completed the mobilization process in 80 days or less. In each of the other five months, 75 percent of the units went through the entire process in less than 72 days. This result reflects the net effects of offsetting performances. Alert and mobilization times rarely met the 30-day standards. But movement to the mobilization station and validation there were often on schedule or better. Thus, units generally met the overall goals.

Figure 3. Total Days from Alert Notification to Validation



SOURCE: Calculated from data provided by the Army Operations Center and First U.S. Army

Observations on Mobilization

The problems encountered in OIF have led to many Army initiatives that will affect mobilization planning and operations. Some bear directly on mobilization performance; others, designed for other purposes, will also affect mobilization. Examples include 100 percent manning of Army Reserve and National Guard units, and active and reserve force rebalancing. But the Army should also address the design and resourcing of the mobilization system itself. The fact that the mobilization system generally met expected standards does not mean that problems did not occur. Some mobilization sites lacked adequate facilities to accommodate the projected flow of mobilized units, and in some cases facilities to house soldiers held to correct medical problems were inadequate. The various information systems did not communicate with each other well.

Needed improvements include the following:

- **A new mobilization model.** The Army should reconsider the "mobilize-train-deploy" model. Mobilization planning must not only support major combat operations but also meet the needs of unexpected contingencies and foreseeable rotational deployments. Each type of mobilization calls for a different concept. For rotational deployments, the Army should consider a "train-mobilize-polish-deploy" model.
- **Improved accountability.** The division of mobilization responsibilities means that no single organization was responsible for monitoring Army mobilization performance and synchronizing mobilization operations with national strategy and higher authorities' directives and procedures. This absence of a central authority led to surprises, friction, and false starts. The Army should consider creating systemwide accountability for mobilization and give a single office responsibility for mobilization process design and performance.
- **Information systems.** Mobilization information systems affect every stage of mobilization from soldier readiness to unit deployment. OIF mobilizations were hampered by outdated and

inadequate information systems. The mobilization community has begun using web-based processes but has far to go.

- **Resourcing.** Improvement to information systems requires resources for development and fielding. Major mobilization stations should have first-class operations centers. Barracks, training facilities, and medical facilities should be brought to high standards. Even such routine processes as clothing issue should be modernized to the standard of 21st century retailing.

In sum, the Army needs a robust, well-managed, and effective mobilization process geared to the 21st century security environment. Such a system, with accountability clearly fixed, would be able to respond to top-down guidance and changing requirements. As a result, the Army would be better able to meet combatant commanders' requirements for Army capabilities when and where they are needed. ◆

In sum, the Army needs a robust, well-managed, and effective mobilization process geared to the 21st century security environment.

Access in an Uncertain World

Since the end of the Cold War, it has become increasingly clear that the United States must be able to project power abroad quickly. The 2001 Quadrennial Defense Review underscored this point by emphasizing deployability, operations in environments where opponents will attempt to foil entry, and protecting bases of operation.[4] However, even as the Army transforms its forces to be more deployable, U.S. adversaries continue to develop asymmetric strategies and means. Adversary anti-access strategies can be defined broadly. RAND Arroyo Center researchers conceived of them as strategies that

- aim to deter, prevent, degrade, disrupt, delay, or otherwise complicate the mobilization, deployment, entry, and buildup of U.S. forces for military operations in a theater;
- can be executed during peacetime, in crisis, and in conflict and can involve strategic, operational, or tactical methods;
- may involve actions against continental U.S., en-route, or in-theater targets;
- may be integrated with broader national strategies to include actions executed during peacetime, crisis, and conflict; and
- may involve actions taken either by an adversary or a proxy.

In the context of the Army's ongoing transformation efforts, it is difficult to determine the level of threat posed by the growing repertoire of anti-access tools that potential adversaries may have available in the future. The research reported here aims to make the anti-access threat more tangible by assessing the efficacy of anti-access strategies—and U.S. and coalition countermeasures—in a small but diverse set of scenarios.

For each scenario, the study team used scenario gaming to examine the actions that might be taken by the United States and its putative adversary and what key challenges and opportunities might present themselves.

Findings From Scenario Gaming

Arroyo researchers concluded that the anti-access threat is a serious and growing one. To reduce U.S. vulnerability to anti-access strategies, the Army and the Department of Defense (DoD) should pursue a range of options that would improve the ability of U.S. forces to gain access to key areas. These options include

- diversifying further the U.S. portfolio of prospective bases and mobility capabilities while reducing requirements for mature infrastructure;
- improving the self-deployability of some forces to support new deployment and warfighting concepts; and
- ensuring capabilities for rapidly assaulting, seizing, and improving bases to make them suitable for the conduct of operations.

The conflict scenarios used in the study were designed to illuminate anti-access strategies and threats in four geographic areas of responsibility: the European, Pacific, Central, and Southern Commands. The scenarios featured capable adversaries in each region—i.e., those who

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The analysis reported in this article is drawn from Eric Larson et al., *Assuring Access in Key Strategic Regions: Toward a Long-Term Strategy*, Santa Monica, CA: RAND Corporation, MG-112-A, 2004. It is available online at http://www.rand.org/publications/MG/MG112/.

[4] The 2001 Quadrennial Defense Review states that "projecting and sustaining U.S. forces in distant anti-access or area-denial environments and defeating anti-access and area-denial threats" is one of the Department of Defense's six operational goals driving transformation of the force.

would be expected to have recourse to the most potent and diverse portfolio of anti-access strategies and capabilities.

We explored anti-access in a Southwest Asia scenario in which Iraq was assumed to be months away from acquiring a nuclear weapon. We also examined an East Asia scenario in which the People's Republic of China sought to resolve the issue of Taiwan's status through military means. And we analyzed a European scenario in which Russia attacked the Baltic states under the guise of protecting Russian minorities. Finally, we considered in somewhat less detail a range of less-than-war operations in Central and South America.

While our assessments of these scenarios led to a reasonably sanguine view of U.S. ability to prevail in each, a number of threats were cause for concern.

Adversary Actions Taken for Strategic Political or Psychological Effect Are Likely to Prove Most Successful

The principal findings from the scenario analyses were as follows:

- Because their weapon systems are likely to lack range, accuracy, and payload during the 2003–2012 period examined by Arroyo researchers, adversaries are likely to have more incentives to use anti-access military capabilities against regional leadership, population, and high-profile soft military targets rather than attempt to destroy a set of bases or other anti-access targets. Moreover, nonmilitary means (cooption, coercion, subversion, information operations, and psychological operations) may prove more effective than military means.
- For the same reason, attacks on bases and other infrastructure are more likely to prove successful for their psychological value—raising the costs of a military action in the hope of getting policymakers to reconsider—than the military significance of what they can reliably destroy.
- Control of chokepoints, while likely to be short-lived, can have important operational effects on the role of land forces and on campaign outcomes.
- Most adversaries cannot at present project power over strategic distances except through special operations forces or terrorist proxies and therefore appear to have limited opportunities to conduct anti-access attacks outside of their immediate theater of operation. Nevertheless, important "wild cards" exist, such as longer-range ballistic missiles with nuclear warheads, and should not be ruled out.
- Technological trends are such that anti-access capabilities could substantially improve beyond the 2012 horizon examined. The proliferation of nuclear weapons, accurate ballistic and cruise missiles, or advanced SAMs would be particularly worrisome.

In particular, adversaries seemed to have a wide variety of nonmilitary carrots and sticks that they might employ to complicate or restrict U.S. access in a region, and in many ways these are more worrisome than the military methods.

Our analysis of these scenarios suggested that greater concern is warranted for actions that might be taken more for their strategic political or psychological effect than for strictly military ends. In particular, adversaries seemed to have a wide variety of nonmilitary carrots and sticks that they might employ to complicate or restrict U.S. access in a region, and in many ways these are more worrisome than the military methods. In several of the scenarios, the study team saw great potential for psychological operations and propaganda as tools for imposing costs on regional partners and allies for cooperating with the United States. This was especially acute in the Southwest Asia scenario, where Iraq cynically sought to link its own situation to the Palestinian issue in the minds of regional Arab and Muslim populations and to erode support for the United States by highlighting its continued support for Israel. Propaganda also played a role in the Baltic scenario, where Russia's claims that it was acting defensively against an expanding NATO found fertile soil among German Greens and peace groups.

Analysis of the Iran scenario provided compelling evidence that under some conditions—in this case, a committed adversary in the geographically advantageous position of controlling a key chokepoint—anti-access strategies can have substantial effect.

The Threats U.S. Land Forces Are Likely to Face Through 2012 Should Be Relatively Manageable but Could Delay Access

Numerous instances occurred in which adversaries' military anti-access capabilities had the operational consequence of forcing the United States to operate, at least initially, from greater distance. However, in none of these games could adversaries actually deny access or delay or degrade it enough to prevent U.S. forces from accomplishing their missions.

Thus, the scenario gaming generally suggested that nonnuclear military anti-access threats should be pretty manageable out to 2012 but that these threats could become far more potent after 2012. Nuclear threats remained an important wild card in the scenario gaming, in the sense that although the use of nuclear weapons would be deterred in most cases, actual use could either destroy needed bases or potentially deter policymakers from continuing with a military operation.

As just described, scenario gaming suggested a reasonably sanguine view of the anti-access problem. Accordingly, the study team analyzed another case in which most would expect anti-access strategies to affect campaign outcomes: Iranian closure of the Strait of Hormuz.

Analysis of the Iran scenario provided compelling evidence that under some conditions—in this case, a committed adversary in the geographically advantageous position of controlling a key chokepoint—anti-access strategies can have substantial effect. More specifically, this modeling suggested that as closure of the strait increasingly delayed the arrival of land forces, campaign outcomes deteriorated, even to the point where strategically important facilities might be lost. Thus, campaign modeling supported the proposition that the success of campaigns could, under some conditions, pivot on the question of timely access. The modeling also showed that the loss of the strait for several weeks could mean that U.S. land forces might play only a limited role in blunting the adversary's offensive.

The U.S. Army and the Joint Community Need to Consider a Wider Range of Anti-Access Scenarios

Taken together, the analysis of these conflict scenarios suggested that the anti-access threat varies by adversary: its effectiveness in regional political and security affairs, military capability levels, geography, and so forth. It also suggests that the overall potency of the *military* anti-access threat may hinge on the adversary's geographic circumstances, especially its proximity to and ability to threaten or control chokepoints, sea lines of communication, and corridors for incoming aircraft. Absent such favorable circumstances, anti-access strategies generally would be expected to have relatively modest effect.

This differentiated view of the anti-access threat suggests that the Army and joint community need to consider the issue in greater detail in the context of a wide range of scenarios. Additional campaign modeling and analysis of the anti-access options available to adversaries are needed, both for the standard planning scenarios used for force planning and for regional commanders' contingency and operational plans. As in so many cases of analysis, the details really do matter.

Toward an Access Strategy

These results suggested a general Army and joint strategy for assuring access, with peacetime, crisis, and wartime elements. In this strategy, during peacetime, the United States should undertake activities that can reassure partners and allies and deter adversaries. Execution of the theater security cooperation plan and Army international activities (AIA), including exercises, military training, military-to-military contacts, and foreign military sales can further this.

But the United States should also develop new options that can expand the portfolio of potential bases and

infrastructure that might be used in a military operation. A range of complementary means is available to accomplish this. The Army and joint community should do the following.

First, increase the number of possible bases and other infrastructure. This can be accomplished in part through negotiations aimed at providing access to additional bases or prepositioning equipment. Investment in sea-based prepositioning or sea bases might improve the access outlook.

Second, improve mobility assets so that they can operate in less developed environments. To the extent that the mobility force's current reliance on mature infrastructure can be reduced and a "go anywhere" force created, the access outlook will greatly improve. For example, a mix of shallow-draft sealift, lighters, and organic docking capabilities could reduce the reliance of the sealift force on deepwater ports and wide berths. Development of a C-17/C-130 trans-shipment concept of operations might similarly improve the access outlook.

Third, improve the deployability of forces to make them more expeditionary. Improving the deployability of air and theater missile defenses, for example, will make it easier to assure partners and allies who are facing ballistic missile threats and to move missile defenses in more quickly. By improving the deployability of long-range fires, land forces might be able to play an earlier and more important role in halting an enemy's advance. The cost-effectiveness of such capabilities obviously would need to be compared with sea-based and aviation alternatives. Finally, improving the self-deployability of some forces, such as attack helicopters, may facilitate both deployment directly into the combat zone and dispersed operations, and thereby improve the forces' ability to enhance access.

Fourth, improve detection, warning, and force protection measures at key bases. Improving the ability to detect and warn of conventional and unconventional attacks and improving force protection and other defensive measures could mitigate the effects of many attacks.

In crisis and war, the United States will have to deploy military forces and defend both deploying forces and the infrastructure they need. In many cases, the leadership and populations of the host nations will also have to be defended. In some cases, U.S. forces may need to improve, seize, or build access. Finally, to ensure continued access, U.S. forces will need to protect forces and bases of operation. Thus, any long-term access strategy for the Army and DoD will involve a wide range of activities while remaining alert for, and adapting to, the unexpected. ◆

Improving the ability to detect and warn of conventional and unconventional attacks and improving force protection and other defensive measures could mitigate the effects of many attacks.

Sustaining an Expeditionary Army with War Reserves of Spare Parts

Operation Iraqi Freedom (OIF) unfolds as the Army continues to develop new force and operational concepts that have important ramifications for logistics support to combat forces. Logistics performance and what it took to achieve it during OIF are likely to affect future Army policies, doctrine, resource requirements, and practices, as well as those requirements that the Army must coordinate with other organizations, such as those for strategic distribution.

The Army has long abandoned its Cold War logistics model, which consisted of assembling large stockpiles of materiel in theater, the so-called "iron mountain." That concept is too inefficient, expensive, and, worst, ineffective for today's expeditionary Army. Instead, the Army relies on meeting demands rapidly and precisely, shipping items as needed to the theater by sea or air. Because historically it has been expected to take some time to get these pipelines flowing, the Army prepositions stocks forward to handle immediate demands, either warehousing them near likely areas of conflict or storing them on ships that can move to the theater when needed. From a sustainment standpoint, the challenge is to get the right items positioned forward in the right locations so that stocks are available when needed and so that scarce and expensive airlift is not used inefficiently. Additionally, war reserve sustainment stocks, both forward-positioned and CONUS-based, provide a critical buffer until the Army can obtain authorization to contract with its providers and they can ramp up production to meet higher wartime demands.

Logistics performance and what it took to achieve it during OIF are likely to affect future Army policies, doctrine, resource requirements, and practices, as well as those requirements that the Army must coordinate with other organizations, such as those for strategic distribution.

RAND Arroyo Center researchers have studied a variety of issues raised by OIF with respect to war reserve secondary items (WRSI). A component of Army prepositioned stocks (APS), these are spare parts, other expendable materiel (e.g., clothing), and subsistence items stored for use in contingencies in different parts of the world. WRSI positioned in CONUS (designated as part of APS), in combination with forward positioned stocks, are intended to augment peacetime stock levels to meet demands from contingency operations until funding is approved and the industrial base can ramp up production. Forward positioned sustainment stocks are meant to provide sufficient stocks in the area of operations until supply can be established. For OIF, stocks positioned in Qatar and aboard two container ships were available to support operations, along with CONUS-based stocks.[5] Arroyo has studied—both conceptually and empirically—the effectiveness of these APS requirements: how well the requirements were resourced, how readily the stocks were integrated into operations, and how well the stocks supported the demands in OIF.

[5] The two container ships were positioned in different parts of the world, the Indian Ocean and the Pacific Ocean, but they were considered "swing" stocks. The pre-OIF APS afloat configuration is being replaced by three regional flotillas.

Requirements Determination

The Army process to determine WRSI requirements starts with the appropriate defense planning guidance scenario to determine personnel numbers, equipment quantities, and the pace of operations. These factors are combined with tables that link parts to equipment, failure rates, other consumption factors, and production capabilities to provide model inputs and develop requirements. The WRSI requirements "on the books" before OIF were quite large: for example, for Southwest Asia, they totaled about two and half billion dollars in spare parts and another billion for clothing, gear, tools, packaged petroleum products, and construction material for CONUS, Qatar, and the container ships. In the case of the ships, requirements far exceeded their storage capacity.

Resourcing the Requirement

Only a small fraction of the requirement was funded. For example, about 6 percent of the WRSI requirements in Qatar and CONUS for spare parts was funded. Of that, most of the dollar value of stocks for Qatar was left "malpositioned" in CONUS, where it had little initial use for OIF. The level of funding and positioning for the other classes of supply intended to be stocked in Qatar was similar. While enough war reserve funds were provided to fill the two container ships, the on-hand spare parts assets still represented less than 25 percent of the requirement.

Quality of the Requirement

To evaluate the quality of the Army's WRSI requirements, we compared them to what was actually demanded in OIF. More specifically, we measured the potential accommodation rates (the percentage of requests that were for items with a requirement) of WRSI requirements against OIF demands for different subsets of items, e.g., all spare parts, parts coded as essential, and parts that have historically "deadlined" Army equipment (a deadlined piece of equipment has one or more serious faults that render it not mission capable). In all cases, the accommodation rates were relatively low, with only a little more than half of the deadlining parts having requirements. Given the large number of parts with requirements, accommodation rates for spare parts in the 90 percent range should have been possible.

Mechanic fixing HMMWV in Iraq.

Additionally, almost half of the spare parts with requirements, both CONUS-based and forward positioned, were not demanded in OIF during calendar year 2003 (it is important to note that these items represented a very small portion of the cost and storage space needs of the requirement). Most items with forward positioned requirements that did not have OIF demands were coded as inactive, insurance lines.[6] Thus they should have been considered poor candidates for forward positioning. Given production lead times, especially from a "cold" start, they do make sense as war reserve insurance items, but they should be held only in CONUS, where the requirement for many would be fully offset by "peacetime" stocks.

Forward positioning is particularly valuable for large items that are expensive to resupply by air and may clog the air channel. But the forward positioned requirement for WRSI in Qatar and for the container ships was dominated by tens of thousands of very small items. In the case of Qatar, such items accounted for 30,000 out of 50,000 spare parts with requirements. Forward positioning of these items did little to relieve the load on air transport, and the sheer number increased warehouse workload and management complexity in the theater of operations.

[6] An item is coded as inactive when it has too few demands to qualify for national stockage. They are included as insurance items because of their essentiality and lead times.

Many parts stocked on the ships were not needed and many parts that were needed were not stocked, including drivers of equipment readiness.

Performance of On-Hand Stocks

Because the WRSI for CONUS and Qatar were largely unfunded, our analysis of on-hand sustainment stocks focused on the two container ships. Of the 16,000 different spare parts on hand, just over half had demands in OIF. The percentage of requests for items with requirements was about 20 percent, which included deadlining spare parts. This means that many parts stocked on the ships were not needed and many parts that were needed were not stocked, including drivers of equipment readiness.

Another issue is that stocks were not immediately ready for issue when the ships' assets were downloaded for transfer into theater warehouses. The ships contained lots of items that would fit in very small bins, but these were bulk stored in large containers. As a result, the theater received containers full of parts that had to be converted into a functioning warehouse just when the need for those parts was most critical.

Recommendations

It is critical to improve the quality of WRSI requirements and for WRSI to be better funded. With inaccurate requirements or insufficient funding, support to the troops will suffer (e.g., low stock availability for many parts in OIF). Thus, the Army should review the process by which it calculates requirements for WRSI. The primary problem appears to be one of data input quality in the modeling process. This is most evident from the fact that many critical parts that tend to show up on deadline reports in the field and that were needed in OIF had no requirement, and tens of thousands of parts with forward positioned requirements had no demands.

The Army should also review its doctrine for forward positioned WRSI and theater general support inventory. Requirements for forward positioned WRSI should focus on two groups, a step that would reflect a change in the WRSI concept. The first group would include the large, bulky items and the very fast-moving ones, because otherwise these burden the air channel. Enough of these items need to be forward positioned to meet immediate demands until resupply by sea can support the contingency (a 75-day plus pipeline for OIF). The second group would include critical parts that consistently deadline weapon systems; enough of these should be stocked until resupply by air can support the operation (a 15- to 30-day pipeline) with some buffer to hedge against disruption in that flow. Available storage space—the number of APS ships and potential warehouses in theater—should be factored into the requirements process so that forward positioned items can be prioritized based on the space available to store them.

Another problem is that forward positioning requirements have been computed from the perspective of a one-time stockpile to last a set number of days without replenishment. In OIF it was apparent that this is not how these stocks were or should be used. Rather, an order quantity and reorder point, to cover the sea or air pipeline as appropriate, needs to be computed as part of the requirements process to realize the benefits of forward positioning throughout the contingency. Finally, from an operational perspective, forward positioned WRSI should be configured as a "turnkey" operation, so that they are ready for use immediately upon arrival.

Turning to CONUS stocks, the WRSI requirements there should be sufficient to cover wartime surge, given a reasonable offset for additional production. Inactive items with WRSI requirements should be positioned in CONUS. Peacetime stocks may fully or partially offset the requirement for many of these slow-moving items. Due to the infrequency of demand for these inactive items, they can be flown to the theater when needed.

Implementing these recommendations should help the Army continue on the path that it started down over a decade ago: movement toward a truly transformational logistics system that can support an expeditionary Army wherever it must go. ◆

Forging a Joint Supply Chain

The rapid advance of U.S. armored forces that led to the fall of Baghdad and Saddam Hussein's regime was made possible by a robust fuel supply and distribution system and a leaner system for other commodities that proved adequate but operated on the edge. In fact, strategic planning for OIF was predicated upon the application of a new support paradigm called Distribution Based Logistics (DBL; see sidebar). In contrast to the logistics operations in the first Gulf War, DBL would not require an initial buildup of large stockpiles in the theater of operations. Instead, it would use much smaller stockpiles and depend more on the quick and reliable delivery of needed supplies. Overall, the new support paradigm worked. In the first history of the major combat operations in OIF, the distinguished British historian John Keegan noted that "Re-supply, quite as much as firepower or air support, was the secret of the coalition's overwhelming defeat of Saddam's forces."[7] Yet for all classes of supply except fuel, there were problems to be overcome. And in the case of one critical supply class, spare parts, the supply and distribution system was "broken" at some times for some units.

Logistics problems in OIF occurred both during the major combat operations observed by Keegan and during the counterinsurgency operations. Among these were distribution problems, including brief disruptions in the supply chain, and shortfalls in national supply for some items. At various times, logistics challenges such as these increased risk, affected quality of life, and hampered equipment readiness.

The reasons for the problems are varied and complex. Some occurred because the Army and its strategic distribu-

DBL means providing support through frequent, reliable distribution flows with focused and right-sized inventories well positioned across the supply chain. The goal is to cover consumption between replenishment cycles at the point of use and to buffer against distribution disruptions and typical variability (that is, the amount of variability experienced when processes are working to "standard"). The sizes of the buffers should be based upon risk tolerance with regard to the types of disruptions that can be weathered, replenishment frequency, and process effectiveness. As processes improve (i.e., as the standard changes), which reduces variability and increases responsiveness, buffers can shrink. Inventories at different "levels" in the supply chain on the battlefield should not be viewed as echelons of supply but rather as well-positioned risk-mitigation measures to cover typical demand and distribution variability and to ensure that there are no breaks in support even when there are short breaks in the flow. Thus this inventory does not have to cover all items, just those that are essential for a given period of time under plausible conditions. The goal of DBL is not to reduce inventory, but to improve support effectiveness and agility. When it is well executed, however, the total theater inventory will generally be lower than what had been required in the past. One might think of it as the appropriate amount to adequately mitigate risk without creating significant waste and overburdening mobility requirements. This contrasts with the notion of never having too much, which does not recognize the costs of inventory in terms of responding to shifting conditions, whether with regard to location or to the nature of an operation, and in terms of the workload and process effectiveness burdens it imposes.

[7] John Keegan, *The Iraq War*, New York: Alfred Knopf, 2004, p. 146.

tion partners (specifically, the Defense Logistics Agency and the U.S. Transportation Command) had not completed their joint transition to the DBL paradigm. Other problems, even some of those with distribution, were independent of the DBL paradigm and would have been an issue regardless of the support concept chosen, especially in the face of the unforeseen scale and duration of the insurgency that developed after Saddam fell.

Arroyo researchers have conducted wide-ranging investigations into the causes and consequences of the logistics problems in OIF. They conclude that DBL has proved to be a viable and desirable paradigm for supporting expeditionary forces. But they also recommend that the implications of DBL should be integrated into a joint supply chain vision. Such a vision should delineate the complementary roles of links in the supply chain, which include DoD agencies, services, and intra-service organizations as well as firms in the private sector. A joint vision predicated on DBL has implications for process design, joint policies, and resource requirements.

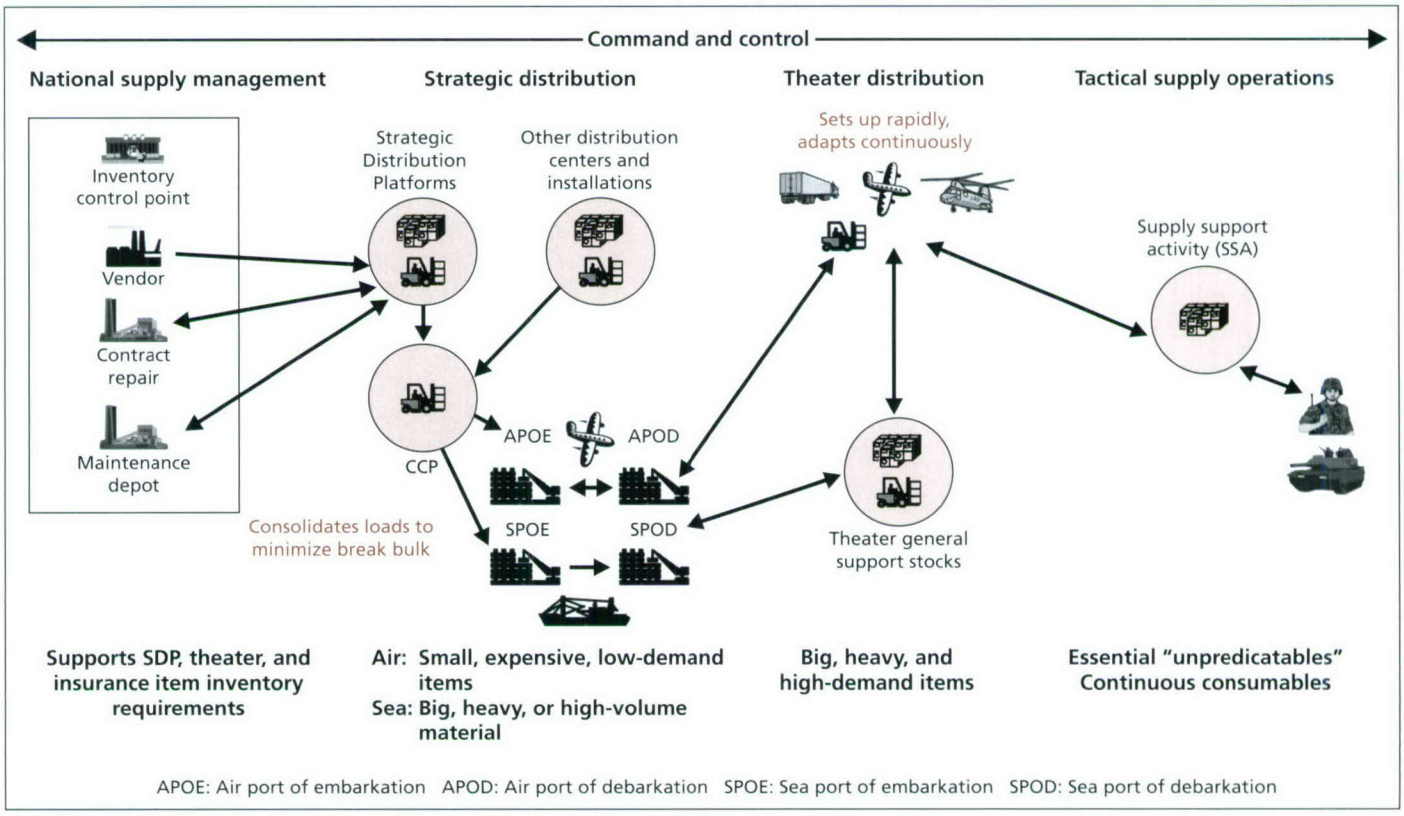
In what follows, we outline key elements of the vision, relate them to specific problems encountered in OIF, and suggest steps that should be taken to ensure that the logistics supply chain operates more smoothly in the next major contingency. The Army and supply chain partners must link all processes tightly to a common vision to ensure that the logistics problems that arose in Iraq do not reappear.

A Joint Supply Chain Vision

Figure 4 lays out a schematic of a proposed joint integrated supply chain based upon DBL. This vision focuses primarily on meeting the readiness needs of units in the field, and secondarily on doing this as efficiently as possible. The figure shows the major elements of the supply chain vision, with the tactical level on the right and the national level on the left. Distinguishing characteristics of each element appear in lighter text.

This vision was not entirely new to the U.S. military organizations that deployed during OIF. Many had been working toward portions of it. Yet not every link in the supply chain was designed and tested in accordance with the vision, and even when the design was in place, actual policies and practices did not fully accord with it, or in

Figure 4. A Joint Supply Chain Vision to Align Organizations and Processes



some cases the policies and practices did not transition well to war. Finally, not all of the equipment and information systems needed to execute the vision fully had been fielded. This was especially the case with command and control systems for logistics situational awareness.

Tactical Supply Operations

The right side of Figure 4 depicts the generation of demands by tactical units and the supply support activities (SSAs) that travel with them and carry the supplies these units are expected to need in the initial phases of combat. For reasons of strategic and tactical mobility, the Army limits the amount of supplies that units carry to those absolutely needed to remain ready to operate. This constraint, along with the capabilities of the rest of the system, has implications for both the range and quantities of items stored. Units should only carry items that they need immediately when demanded or that they need continuously. These include spare parts critical to readiness, food, water, fuel, medical supplies, ammunition, lubricants, limited materiel for building defensive positions, and other basic subsistence items. This list does not include items that units can wait for, such as clothing or nonessential spares, or items whose use can be scheduled in advance, such as armored vehicle track for full track replacement at regular intervals.

From a quantity standpoint, the aim at this tactical level should be to have enough of each stocked item to avoid running out under realistic assumptions, which includes a safety margin to hedge against uncertainty. The quantity needed varies substantially among commodities, depending upon demand variability and other factors. For example, it is safe to assume that each person will eat a specified number of meals each day, so the system can "push" out supplies to cover expected consumption on a regular basis, greatly limiting the amount of food that units must carry.

In contrast, demand for some spare parts varies tremendously, and there are literally tens of thousands of different parts that a maneuver brigade might need. It is possible to make reasonable predictions about what parts will be needed across units and establish a range of possibilities, but it is not possible to make precise forecasts of what each unit will order in a short period of combat. Thus, spare parts should not be sent forward until equipment failures create a "pull" on the supply chain, with a unit specifically requesting them based upon maintenance or inventory replenishment needs, and units need to carry enough of these items to cover demands up to a desired level (e.g., what is the likely range of demand quantities during an intense week of combat and what portion of the range does the Army want to cover?).

Units should only carry items that they need immediately when demanded or that they need continuously. These include spare parts critical to readiness, food, water, fuel, medical supplies, ammunition, lubricants, limited materiel for building defensive positions, and other basic subsistence items.

In actual operations, the problem is often less one of determining the minimum amount of supplies and storage capacity needed than one of using relatively fixed carrying capacity effectively. Unless augmentation is available, each unit must be able to carry its supplies on its own vehicles. So in general, this tradeoff between readiness and the transportation assets needed to move supplies must be well treated in the force design process to determine the "right" level of lift capacity given to a unit to move its own supplies. The tradeoff must also be considered in the deployment planning process if the operation is not of the sort for which a unit was designed, which could require augmentation. For example, if a plan calls for the first resupply after five days and the unit can carry only three days of supplies, it will need additional trucks and trailers.

In OIF, SSA stocks were quickly depleted when initial replenishments were disrupted by distribution and communication problems (e.g., support organizations were unable to transfer electronic supply requests to higher-level support organizations while conducting offensive operations), with delays in strategic distribution hampering recovery. Additionally, the quantities of some items held by SSAs were insufficient for the demand rates experienced in OIF. For prepositioned SSAs, drawn by the 3rd Infan-

try Division with prepositioned equipment stored aboard ships and in Southwest Asia, the mix of parts was not well matched to the equipment. However, by cannibalizing damaged equipment and using impaired but still operable partially mission capable equipment, commanders were able to continue to move forward with what they considered high combat power through the collapse of Saddam Hussein's regime. Although deferring maintenance in this way contributed to equipment readiness problems in later operations, it enabled lead units to complete their main mission.

Theater Distribution

Shown to the left of the tactical supply operations in Figure 4, the theater distribution system links national suppliers and centralized theater inventory to units in the field. Developing and managing theater distribution are complex operations. For a contingency operation, the theater distribution system often must start from scratch and continually adjust to the number, type, and location of forces supported as well as to the varying needs that arise in different phases of an operation. This requires a well-planned and flexible choreography to maintain adequate distribution capacity, balanced across echelons, to keep supplies flowing reliably. To avoid developing early backlogs and shortages that can be difficult to recover from, the setup of the theater distribution system must be rapid, with the requisite units and resources carefully phased into the deployment flow. Reliable flows also require adequate security for supply lines and logistics units, which has relatively large implications for tactical support unit resource needs and total operational force requirements.

For a contingency operation, the theater distribution system often must start from scratch and continually adjust to the number, type, and location of forces supported as well as to the varying needs that arise in different phases of an operation.

In OIF, a confluence of factors made cargo truck capacity inadequate during major combat operations, especially at the outset. When a change in the troop support concept caused bottled water use to be extended beyond the initial five-day plan, the demand for trucks increased well beyond expectations. Additionally, DoD did not time the mobilization and deployment of cargo truck units so that the system could be fully prepared to meet anticipated demands from the first day of operations. Difficult road conditions, differing from the intelligence picture, further reduced the effective capacity of those cargo trucks that were available. Finally, the severe sandstorm that descended a few days into combat briefly disrupted the movement of supplies. Together, these factors slowed and restricted the delivery of bulk supplies such as food, water, and ammunition, and virtually cut off the flow of spares.

The theater distribution system must also provide nearly instantaneous emergency response. Battlefield circumstances can quickly and unexpectedly deplete essential supplies, and demand can remain high. In particular, this can occur with ammunition during heavy, unexpected fights, creating critical spot shortages. Rapid transportation, such as helicopters, can be used to handle these situations.

Strategic Distribution

Strategic distribution consists of two major sets of activities: preparing materiel for shipment from the United States, and moving it to the operational theater.[8] These are depicted in Figure 4 by the strategic distribution platforms, consolidation and containerization points (CCP), other distribution centers, and the air and sea ports of departure and arrival. To enable rapid deployment and initiation of operations with a capable but austere theater distribution system, it is critical that the strategic distribution system, based largely in the United States, minimize the distribution workload required in theater.

In particular, it makes sense to take shipments intended for combat units and consolidate them at per-

[8] For an overview of strategic distribution and its performance in Operation Enduring Freedom, see Marc Robbins et al., *The Strategic Distribution System in Support of Operation Enduring Freedom*, Santa Monica, CA: RAND Corporation, DB-428-USTC/DLA, 2004. It is available online at http://www.rand.org/publications/DB/DB428/.

manent, fixed facilities, enabling rapid delivery to SSAs without repackaging in the theater. Building loads in CONUS for a given SSA supports the seamless delivery of materiel from distribution centers to SSAs with limited delay and minimal in-theater workload. No stops are necessary to unpack, resort, and repackage loads. Rather, they can simply be transferred from one mode of transportation to another. The better the consolidation of materiel on inter-modal pallets and in containers, the better the synchronization of consolidated shipment construction with transportation schedules, and the more coordinated the transshipment flow of cargo across modes and nodes, the faster the delivery of supplies to their customers will be. Tightly scheduling and coordinating when loads are declared full, when trucks run from a warehouse to a port, when planes leave each day, when ships sail, and so on, enables effective synchronization. Positioning inventory at the start point of scheduled transportation where loads are consolidated for overseas shipment is the final step to moving items to theater as fast as possible.[9]

The early phases of OIF illustrated the problems that ensue when loads are not well packed in the United States in a way that the theater distribution system is designed to handle. The CCPs supporting OIF initially sent so-called "mixed" loads—those containing supplies for many different units operating in Iraq—to the theater distribution hub in Kuwait (and later to a central hub in Iraq). This increased the workload in theater, where the loads had to be broken down and repacked, exceeding theater and unit-level capabilities and resulting in delays and "misdirected" shipments, which exacerbated the shortage of parts at the SSAs and units. Additionally, as demand from the mounting counterinsurgency grew well beyond expectations, CONUS distribution center capacity was not ramped up quickly enough, leading to substantial delays within CONUS as warehouse backlogs developed.

National Supply Management

The mission of national supply, shown on the far left side of Figure 4, is to have an item available at the right place for shipment upon demand. That is, the system must ensure that enough supplies are ordered and positioned to support readiness efficiently. In peacetime, the system should purchase enough inventory to meet wartime demands until production can increase deliveries as needed to fill the distribution pipelines. Good inventory support requires effectively structured and funded war reserves and agile "surge" processes. These processes include estimating the requirements to support a contingency, gaining approval to order supplies in advance of operations, and the actual production of supplies by Army arsenals and maintenance depots and private-sector firms in the Army's industrial base.

It makes sense to take shipments intended for combat units and consolidate them at permanent, fixed facilities, enabling rapid delivery to SSAs without repackaging in the theater.

As operations continued at a heavy pace into the summer of 2003 and beyond, national stock availability became an increasing problem. War reserve requirements did not include many critical items and were poorly resourced, limiting their value in meeting the Army's requirement for spare parts until a production surge could kick in. The inadequacy of war reserve requirements resulted from planning guidance that limited war reserves to five months of combat operations, which is shorter than the lead times for many parts, and from problems with the accuracy of the processes for determining requirements. Despite a lack of robust war reserves, a production surge for Army-managed spare parts, which include the major components found on most weapon systems, was not funded until the second half of 2003, several months into OIF. Combined with the limited war reserve stocks, this meant that the surge in production and procurement for OIF came too late to prevent the high, sustained demand rate from depleting inventories throughout the supply chain. This led to a high level of backorders and, ultimately, to a lower level of equipment readiness.

[9] Mark Y. D. Wang, *Accelerated Logistics: Streamlining the Army's Supply Chain*, Santa Monica, CA: RAND Corporation, MR-1140-A, 2000. It is available online at http://www.rand.org/publications/MR/MR1140/.

Effective joint C2 will ensure that the various organizations spanning the supply chain remain integrated and focused on the common objective of providing the best overall support possible.

Theater General Support Stocks

If spare parts and other supplies could be shipped cheaply and quickly from the United States to units in combat, there might be no need for prepositioned stocks deployed forward in various theaters of operations. In fact, for small, expensive items like circuit cards that can be flown quickly and in bulk to the theater of operations, forward support stocks are largely unnecessary. Large, heavy items like tank tracks, on the other hand, are extremely expensive to ship by air. It is far cheaper to ship them by sea, but since sealift takes upwards of thirty days to arrive at distant theaters, it is necessary to stock thirty days' supply of these items forward in the theater. Doing so saves money, while also freeing scarce high-value and high-cost airlift for critical missions.

Two general types of items should be positioned forward to minimize the reliance on airlift for sustainment. The first type consists of items with large, smooth demands—those items that continuously get consumed and generate large volume regardless of weight and size. Food is the primary example. The other type consists of big, heavy items with a relatively high ratio of shipping cost to purchase cost, such as construction materiel, ammunition, some spare parts like track, and other items such as tents. From a sustainment standpoint, positioning sizable stocks of these items forward saves airlift for lower-demand, smaller items; expensive items; and emergency missions.

In OIF, the parts and other supplies stored forward for contingencies in Southwest Asia—warehoused in Qatar and aboard two ships, designated as "swing" stocks—were not well configured to support operations or reduce demand on airlift. Many of the parts in these forward stocks were never requested by combat units. And many large, heavy parts were not stocked at all, necessitating the use of airlift for resupply, at considerable cost. Additionally, small parts were bulk stored in large containers and had to be unpacked and organized before orders could be filled. Many of these relatively small items could easily have been provided from CONUS via airlift but required considerable effort to organize and manage in theater. Together, these factors made rapid initiation of effective theater supply operations difficult.

Command and Control

Depicted at the top of Figure 4 is the final crucial element of the supply chain: joint command and control (C2). Effective joint C2 will ensure that the various organizations spanning the supply chain remain integrated and focused on the common objective of providing the best overall support possible. C2 serves four key functions.

First, C2 must integrate planning so that each organization in the supply chain knows precisely what its suppliers are doing and what its customers expect. The detailed policies and processes of every organization must be designed and exercised to ensure tight alignment with the overall vision and with its customers and suppliers. If one organization in the chain plans while using incorrect assumptions about the practices of another, serious problems can develop. In OIF, for example, CONUS load-building was not aligned with theater distribution capabilities, nor were theater inventory requirements well aligned with the ideal use of different strategic transportation modes.

Second, once a planned process is being executed, monitoring and control are crucial to ensure that it is working well. Problems need to be identified and corrected as soon as possible. This requires good data transformed into effective information for people who can fix a problem quickly or change the appropriate portion of the supply chain. For example, incorrect unit address codes were sometimes not corrected for several weeks, disrupting the flow of spare parts to units.

Third, the same kind of information also enables the managers of the supply chain to use assets efficiently.

Fourth, this information is crucial to good situational awareness. The better the situational awareness, the more effective the planning and decisionmaking processes conducted by commanders and their staffs will be. They

can more accurately judge risk and when to continue with a plan or pursue a different course of action. In this vein, logistics situational awareness can affect operational and even strategic decisionmaking in addition to enabling more effective support within a broader operational plan. In OIF, the lack of situational awareness sometimes increased the perceived level of risk.

Conclusion

The vision described in this summary is indeed becoming a reality. The Defense Logistics Agency (DLA) and U.S. Transportation Command (USTRANSCOM) have moved close to this vision in support of the Army. Within the Army, SSAs are stocking more critical readiness items than they were a few years ago and are continuing to improve their focus on such items. In OIF, the Army has begun to increase the quantities of items held in SSAs to reflect wartime conditions more accurately. New sustainment units of action and more modular logistics units being developed by the Army promise to improve deployment planning and theater opening. Many initiatives are under way to improve theater distribution capabilities, whether through more secure support units or aerial delivery capabilities. Inventory is increasingly being concentrated in two Strategic Distribution Points (SDPs), one on each coast, to reduce distribution steps. These SDPs closely coordinate with air and seaports on their respective coasts, and load consolidation centers collocated with the SDPs build SSA-level loads for overseas shipment. Army Materiel Command is introducing lean manufacturing into its repair depots to improve responsiveness.

Many of the problems in OIF, though, arose in the transition to war, when the Army and its supply chain partners had to quickly reconfigure the system and increase capacity. Additionally, resource determination and approval decisions were often slow, affecting strategic distribution and national supply and impeding the ability to match the high sustainment demands of counterinsurgency operations. Building on the analyses of sustainment in OIF, current projects in RAND Arroyo Center are helping the Army to develop solutions to these problems. ◆

Survivability of Transport Aircraft

Historically, when commanders have been able to exploit operational maneuver (the positioning of forces in depth on the battlefield), they have gained significant advantages and often victory over their adversaries. Despite its importance, however, operational maneuver has been difficult to carry out. On one hand, modern transport aircraft can deliver forces rapidly, but they can generally move only light forces in large quantities. These forces have limited tactical mobility and combat capability once delivered. On the other hand, heavy armor forces that are tactically agile and offer substantial ground combat capability generally move relatively slowly. Such forces typically move on the surface network system (e.g., roads, rail, and sea). Thus, the ability to combine speed and combat power has become a modern warfighter's dilemma. Resolving this dilemma could revolutionize ground operations on a future battlefield.

Searching for ways to resolve the dilemma, the Army has been developing a new way to fight, one that involves armored vehicles that are much lighter than today's and equipped with advanced information technologies.[10] The combined capability of advanced transport aircraft in conjunction with future ground vehicles represents a central theme of a transformed military force.

Can They Survive?

With respect to technological constraints, a major issue is whether large aircraft can survive modern air defense systems. Since the end of the Cold War, the air defense environment has in some ways become more dangerous for aircraft. Surface-to-air missiles (SAMs) are proliferating. Advanced air defense systems ranging from man-portable air defense systems (MANPADS) to larger multi-vehicle, high-altitude air defense systems are being sold openly by various countries. In parallel, SAM technology and system capabilities continue to improve as an asymmetric response to U.S. air supremacy.

At the request of the Army Science Board (ASB), RAND Arroyo Center assessed the survivability of large transport aircraft in a plausible future small-scale contingency (SSC).[11] Using a conceptual framework developed by the ASB, Arroyo, through its Joint Warfare Simulation and Analysis (JWSA) group, identified and then conducted a "quick-look" assessment of a range of survivability concepts and technologies. Quantitative, high-resolution models and simulations were part of the analytic process.

Survivability Technologies Are Becoming Available

Although the best course of action might be to operate outside of enemy airspace (or above it), this may not always be possible. For instance, where aircraft may be exposed to air defense systems, both near-term and farther-term technologies could be integrated into a layered concep-

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Material in this article is drawn from John Matsumura et al., *Survivability Options for Maneuver and Transport Aircraft: Analytic Support to the Army Science Board*, Santa Monica, CA: RAND Corporation, MG-123-A, 2004. It is available online at http://www.rand.org/publications/MG/MG123/.

[10] Light forces would have the additional benefit of being strategically deployable (in a matter of days) with the appropriate allocation of airlift.

[11] The threat was based on a modernized version of forces seen in Operation Allied Force in Kosovo in 1999.

tual framework posited by the ASB. Specifically, the ASB envisioned a survivability framework that included three tiers: preparation of the battlefield (e.g., locating air defense systems), protecting the entire flight of aircraft, and protecting individual aircraft. Following the ASB framework, Arroyo researchers broke the technologies down according to the kind of protection or layer in which they contribute. They categorized the technologies as either near term, where the technology is either already proven or is potentially available within the next few years or so, or farther term, where the technology is seen as somewhat less mature but could be available for implementation within the next decade or so. A summary of these technologies appears in Table 2.

For near-term technologies, perhaps most notable are the infrared countermeasures systems, which typically use an array of passive infrared sensors to detect the launch of a missile (e.g., a shoulder-launched MANPADS). After detection, these sensors can orient either a high-energy lamp or laser that can "blind" or damage the sensor of an incoming missile, causing it to lose its lock on the aircraft. Two specific systems available today are the Directional Infrared Countermeasures (DIRCM) system and the advanced threat infrared countermeasure (ATIRCM) system. These systems have already been shown to provide some protection against different kinds of IR-guided missiles.

The Army has been developing a new way to fight, one that involves armored vehicles that are much lighter than today's and equipped with advanced information technologies.

A farther-term technology that shows theoretical promise is the unmanned aircraft, specifically the unmanned combat aerial vehicle (UCAV) and the unmanned combat armed rotorcraft (UCAR). These systems can potentially serve as decoys, where they are intermixed into a transport package, or as "hunters" that rapidly neutralize air defense systems as they expose themselves to engage the flight of the transports. If this technology matures, both applications could evolve.

Individual Technologies Have Limited Effect on Survivability in a Robust SSC

At the outset of this research, the expectation was that the novel application of technologies could overcome the survivability challenge. However, no single technology

Table 2. Near- and Farther-Term Technologies for Improving Survivability of Large Transport Aircraft

Layer of Survivability	Near-Term Technologies to Incorporate	Farther-Term Technologies to Develop
Battlefield preparation	• Advanced RSTA systems (e.g., foliage penetration radar, small, agile unmanned aerial vehicles (UAVs), or unattended ground sensors) • Prep fires using area weapons (e.g., fuel-air explosives)	• Long endurance, autonomous loitering aircraft/missile, with target recognition • Long-haul command, control, and communications • Clearing of landing zones with energy weapons
Team protection	• Low-cost expendable decoys • Small high-speed anti-radiation missile (HARM) • Low-cost autonomous attack submunition (LOCAAS)	• Unmanned Combat Armed Rotorcraft (UCAR) • Directed energy (solid state lasers) for hard kill of airborne SAM
Individual protection	• Suite of Integrated Infrared Countermeasures (SIIRCM) • Directional Infrared Countermeasures (DIRCM) • Suite of Integrated Radio-Frequency Countermeasures (SIRFC) • Hybrid lightweight armor	• Airborne version of the small low-cost interceptor device (SLID) • Directed energy; Multifunction electro-optics for defense of U.S. aircraft (MEDUSA) • Signature reduction • Intelligence obscurants

assessed in the SSC scenario completely ensured survivability of transport aircraft in defended airspace. This quick-look analysis considered both medium- and low-altitude ingress approaches.

For medium-altitude cases, where the transports flew in without any protection, on average most of the 30 aircraft in a transport package were shot down, with medium-altitude systems causing the majority of the losses.[12] When flown at low altitude, results are similar: most were shot down, with MANPADS and guided anti-aircraft artillery (AAA) accounting for more of the kills. From this baseline set of cases, Arroyo researchers conducted a number of excursions to assess the effect of joint suppression of enemy air defense (JSEAD) and destruction of enemy air defense (DEAD), local landing zone (LZ) preparation, unmanned aircraft serving as decoys, unmanned aircraft armed with anti-radiation missiles, and a notional active protection system (APS).[13]

The results show that individual concepts and technologies can notably improve survivability, with gains ranging from about 20 to about 70 percent. The use of low-altitude ingress with an unmanned platform serving as escorts and hunters armed with a high-speed anti-radiation missile (HARM) was the most effective of the individual cases examined. In this case, we assumed the enemy would engage the formation as aircraft presented themselves, typically shooting at unmanned escorts before the transports. While this resulted in losses of escorts, the air defense systems were effectively suppressed. Even with improved survivability, losses of transport aircraft were relatively high (and probably unacceptable), ranging from 26 to 53 percent for a single insertion involving 30 aircraft, depending on the altitude flown.

Layered Defenses Can Improve Survivability

Survivability technologies were more effective when they were used together. Specifically, a layered, system-of-systems survivability approach provided better survivability for transports in this scenario. Using the ASB guidance, survivability starts with intelligence preparation of the battlefield, involves integration of manned and unmanned operations through team protection techniques, and ends with self-protection technologies for individual aircraft. The interaction of the technologies is complex, but in general better survivability results from the mutually reinforcing nature of the layers. Locating enemy air defense systems makes it possible to destroy more of them, which means that fewer systems are available to attack the incoming aircraft. Fewer systems means that the effect of the decoys is relatively greater, i.e., they deceive a larger fraction of the remaining systems, thus further reducing the number of shots fired at the transports. In turn, the effect of the killer UAVs is relatively greater in terms of the portion of the remaining systems they destroy. And the aggregate attrition means that the individual aircraft protection systems have fewer threats to defeat.

With a combination of unmanned escorts, JSEAD/DEAD focused on eliminating the SA-15 threat, and landing zone preparation, survivability improves significantly. For the low-altitude cases, the loss rate declines to roughly 15 percent. Results are not quite as favorable for the medium-altitude ingress cases, with the loss rate falling only to 21 percent.

Applying additional advanced technologies, including armed unmanned escorts along with a notional active protection system, improved survivability of the manned aircraft platforms even more (at the expense of the unmanned escorts). For the low-altitude ingress case, almost all (but not all) of the aircraft survive. Again, results were somewhat less favorable for the medium-altitude case, but most aircraft get through. Interestingly enough, the active protection system technology, which by itself offered little improvement to survivability of the platforms, improved survivability when used in conjunction with other capabilities. In some ways, this last layer of defense provided a means to overcome the remaining air defense units or "leakers" that were not otherwise dealt with in this dense air defense environment.

Observations

In some ways, this research involved a highly analytic and "clean" representation of the interactions of air defense and

[12] In the analysis, there were no high-altitude SAMs, such as the highly capable "double digit" SAMs.

[13] In the analysis, assumptions were made on the success of the operation. For example, the JSEAD aspect of research was conducted parametrically, which assumed removal of SA-15s and partial removal (5 percent) of 2S6 and MANPADS.

aircraft. For example, the analysis assumed that all enemy systems were not only operational and online but also alert and ready to fire. Clever deception methods could reduce the number of systems ready to fire. The effect of poor weather, obscurants, or other countermeasures would also reduce the effectiveness of the air defense systems. Thus, by one argument, the cases examined in this analysis tended to represent a worst case in risk.

On the other hand, a critical assumption here is that the JSEAD/DEAD mission, which is assumed to neutralize the most capable air defense system postulated in this SSC (the SA-15), is effective. If this assumption proves to be wrong, much of the corresponding cumulative survivability gain disappears. Additionally, a clever foe could potentially find ways to neutralize many of the technologies examined here.

Overall, this research suggests that operating in defended airspace even within the context of a SSC, albeit a sophisticated one, is a daunting proposition. Even the "best case" assessed included the loss of an aircraft. While a layered concept and associated technologies can dramatically improve survivability over flying transports alone, such an aggressive deployment approach must be done judiciously, and the operational benefits must be weighed against potential risk.

An analysis of transports delivering their cargo to the "seam" or "edge" of the defended airspace as opposed to flying over shows that all transports survive. With this kind of deployment, the survivability concepts and technologies serve more as a useful hedge against a wide range of battlefield uncertainties, including being able to find the seam of the defended airspace. ◆

Securing the Homeland

Reserve Component soldier helping Border Patrol search vehicles at border crossing.

The Army has played a critical role historically in ensuring the nation's security at home and can expect to be called upon in the future to counter terrorist attacks and respond to other types of domestic emergencies. While the primary and immediate responsibility for homeland security (HLS) rests with civilian organizations and the National Guard working for the state governors, history shows that the Army must be ready to plug any gaps those organizations cannot fill. The Army has already improved its planning and capabilities for HLS, which is defined as activities in support of civilian organizations in domestic emergencies, including terrorist attacks, natural disasters, and civil disturbances.[14]

The analysis described here explores whether the Army should do more to hedge against the risks of being inadequately prepared for HLS tasks, given a world where terrorists have shown that they can and will launch mass-casualty attacks within the United States and where the capabilities of civilian law enforcement agencies and emergency responders to respond to such attacks are expanding but still untested.

To do this, Arroyo researchers designed a hybrid approach to dealing with HLS's uncertainties and the Army's requirements—one that focuses on possibilities the Army might wish to hedge against. The possibilities were based on different assumptions about the characteristics and seriousness of the terrorist threat, the adequacy of the capabilities of civilian organizations, and the nature of competing demands on Army forces overseas. The possibilities, while theoretical, are plausible and could pose serious risks to the nation if they were to occur.

The approach goes on to define ways in which the Army could prepare *today*, by conducting more-specialized training, by improving its responsiveness, or by augmenting certain types of its capabilities. Table 3 describes the five theoretical possibilities we explored and illustrative Army responses. Table 4 describes the HLS benefits of each Army response.

Obviously, the Army would take such steps if they did not cost anything. But this is not the case. All of the potential Army responses involve costs, including those of raising or not raising the Army's manpower caps, the costs to the Army's other missions, financial costs, and costs in the form of provoking political resistance (see Table 5). Financial costs would be higher than Table 4 suggests if the Army's manpower caps were raised.

What this analysis reveals is that adopting any steps to improve the Army's HLS capabilities would result in *certain* costs today, with only the *promise* of future benefits were any of these HLS possibilities actually to occur. Without being able to predict the future, the choice for the nation, then, is what kinds of HLS risks it is willing to assume and whether to undertake a hedging strategy.

The analysis reported here is drawn from Lynn E. Davis et al., *Army Forces for Homeland Security*, Santa Monica, CA: RAND Corporation, MG-221-A, 2004. It is available online at http://www.rand.org/publications/MG/MG221/.

[14] Our definition encompasses what the Department of Defense calls Civil Support missions: Military Assistance to Civil Authorities (MACA), Military Assistance for Civil Disturbances (MACDIS), and Military Support to Civilian Law Enforcement Agencies (MSCLEA).

Table 3. HLS Possibilities and Illustrative Army Responses

Possibility	Illustrative Response
National Guard inadequately prepared, because of focus on conventional wars	Improve National Guard's HLS capabilities by providing DoD Title 32 funding and improved sharing of state assets
Active-duty component (AC) is not available quickly enough or adequately trained to respond to large-scale domestic emergencies	Dedicate brigade for rapid reaction, rotating between AC and National Guard (3,600 soldiers)
Law enforcement combined with available Army counterterrorism capabilities cannot meet demands of future terrorist attacks	Create rapidly deployable and dedicated AC force for combating terrorism (6,200 soldiers)
AC cannot respond adequately to large-scale domestic emergencies, because significant numbers are deployed overseas	Give National Guard primary responsibility for HLS activities by creating dedicated rapid-response regional civil support battalions (8,900 soldiers)
Units critical for HLS in U.S. Army Reserve (USAR) are not available because they are deployed overseas, not ready quickly enough, and prohibited by statute from conducting all missions	Dedicate pool of USAR units to exclusive HLS mission (7,560 soldiers)

Table 4. Benefits of Army Responses

	HLS units are . . .				How accomplished	
Army Response	More responsive	Available	Specially trained	AC overseas readiness	Force structure	Planning
Army National Guard Training			X			X
AC/Army National Guard HLS Ready Brigade	X	X	X			X
AC/Combating Terrorism Force	X	X	X		X	
Army National Guard Primary HLS Responsibility	X	X	X	X	X	
Dedicate Rapid USAR Units	X	X	X	X		X

This analysis suggests that a multifaceted hedging strategy on the part of the Army could make sense. Arroyo researchers recommend the following four actions.

- First, given the National Guard's responsibility and availability to respond to domestic emergencies, the Army should support legislation that would make it possible for the Department of Defense (DoD) to fund HLS activities and for the National Guard to share its resources more easily across state borders. The Army should also seek the necessary statutory changes so that the USAR can conduct all HLS missions, including responses to natural disasters.
- Second, given the possibility that units in all components of the Army may be unavailable because of deployments overseas and the need already acknowledged by DoD for units in all of the Army's components to be ready and on alert, the Army should dedicate some forces to HLS emergencies, making them

Table 5. Estimated Costs of Army Responses ($ Millions)

Army Response	Startup Costs	Annual Costs
Army National Guard Training	0	20
AC/Army National Guard HLS Ready Brigade	0	200
Combating Terrorism Force	1,000 to 1,400	0
Army National Guard Primary HLS Responsibility	400 to 600	0
Dedicate Rapid USAR Units	0	0
NOTE: Assumes no changes in Army end strength.		

ready for rapid deployment and ensuring that they are appropriately trained.

- Third, because the prospective capabilities and deficiencies of civilian organizations are so uncertain, the Army should hedge again by dedicating a mix of forces for HLS with some units trained in specialized law enforcement capabilities.
- Fourth, the dedicated units should be drawn from the National Guard to permit the active-duty Army and supporting USAR units to be available for deployments overseas and to capitalize on the Guard's historical experience in domestic emergencies and links to state and local emergency responders. To be effective as a hedge, the National Guard would need to create standing regional HLS task forces across the country, with units dedicated and trained for HLS and with capabilities for rapid response.

The nation must decide whether it is worth bearing today the costs of making the Army better prepared for HLS than it presently is to *hedge* against a future that is uncertain, but one that could involve serious risks if the Army were found unprepared. ◆

The nation must decide whether it is worth bearing today the costs of making the Army better prepared for HLS than it presently is to* hedge *against a future that is uncertain, but one that could involve serious risks if the Army were found unprepared.

Publications

This section lists and abstracts RAND Arroyo Center research published since the last Annual Report. All publications may be obtained from RAND's Distribution Services: telephone 310.451.7002; fax 310.451.6915; email order@rand.org. Additionally, all publications may be viewed in their entirety on RAND's web site, *http://www.rand.org*

Alternative Futures and Army Force Planning: Implications for the Future Force Era

Brian Nichiporuk
MG-219-A
http://www.rand.org/publications/MG/MG219

This study attempts to help the U.S. Army with force planning for the 2025 era by using the tool of alternative futures analysis. It bounds the future the Army will face by laying out a representative spectrum of different "future worlds" that hopefully illustrate the complete universe of future missions. By mixing and matching possible trends across five key areas (geopolitics, economics, demographics, technology, and environment), six alternative futures are created: "U.S. unipolarity" and "democratic peace" (best cases)," major competitor rising" and "competitive multipolarity" (medium-good cases), "transnational web" (medium-bad case), and "chaos/anarchy" (worst case). After explaining the main features of each future, the study creates an appropriate "Army type" for each, through a three-step process: (1) a representative combat scenario was created for each future, (2) the strategies-to-tasks methodology was used to set out the raw capabilities needed for a given scenario, and (3) the force characteristics and size required to meet the needs presented in the capability statements were formulated. All the needed characteristics were then bundled together to form a basic Army type for a given future. The report concludes with a review and discussion of the common desired characteristics found across the six types.

American Public Support for U.S. Military Operations from Mogadishu to Baghdad

Eric V. Larson and Bogdan Savych
MG-231-A
http://www.rand.org/publications/MG/MG231

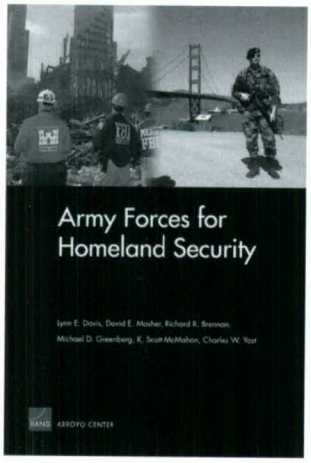
The support of the American public is widely held to be a critical prerequisite for undertaking military action abroad. This monograph examines American public opinion about the use of military force in support of the global war on terrorism (GWOT). Its purpose is to describe public attitudes toward wars and other large military operations over the last decade, to delineate the sources of support and opposition for each war or operation, to identify the principal fault lines in support, and to illuminate the factors that are consistent predictors of support for and opposition to military operations. Although the focus is on public opinion toward U.S. military operations in Afghanistan, Iraq, and other GWOT-related theaters of action, the authors also examine public opinion on a number of military operations conducted before the attacks of September 11, 2001, including the final stages of the U.S. military intervention in Somalia and the U.S. interventions in Haiti, Bosnia, and Kosovo.

American Public Support for U.S. Military Operations from Mogadishu to Baghdad: Technical Appendixes

Eric V. Larson and Bogdan Savych
TR-167-A
http://www.rand.org/publications/TR/TR167

This document supplies the technical appendixes for a study that describes American public opinion toward the use of military force in support of the global war on terrorism (GWOT), delineates the sources of support and opposition, and identifies potential fault lines in support. The final report is by Eric V. Larson and Bogdan Savych, *American Public Support for U.S. Military Operations from Mogadishu to Baghdad*, Santa Monica, CA: RAND, MG-231-A, 2004.

These appendixes describe bivariate and multivariate statistical analyses of respondent-level public opinion data from polling during the final stages of the U.S. military intervention in Somalia, the peace operations in Haiti, Bosnia, and Kosovo, the war against the Taliban and Al Qaeda Organization in Afghanistan, and the overthrow of Saddam Hussein's Baathist regime in Iraq.

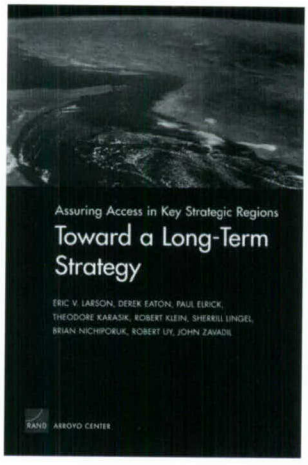


Army Forces for Homeland Security

Lynn E. Davis, David E. Mosher, Richard R. Brennan, Michael D. Greenberg, K. Scott McMahon, Charles W. Yost
MG-221-A
http://www.rand.org/publications/MG/MG221

Although the responsibility for responding to terrorist attacks and other domestic emergencies falls primarily on various civilian agencies, the U.S. Army has always had a role to play in plugging any gaps in civilian capability. Should the Army adopt a hedging strategy to meet the risks of future terrorist attacks and other emergencies? The authors lay out five possible shortfalls in civilian and Army capabilities and suggest five possible responses the Army can begin today to ameliorate future risks. They also estimate the costs, both monetary and political, of the responses. They conclude that the nation needs to decide whether to bear the costs today in order to hedge against future risks.

A research brief is also available for this report: RB-9069-A, *An Army Strategy for Homeland Security.* http://www.rand.org/publications/RB/RB9069/



Assuring Access in Key Strategic Regions: Toward a Long-Term Strategy

Eric V. Larson, Derek Eaton, Paul Elrick, Theodore Karasik, Robert Klein, Sherrill Lingel, Brian Nichiporuk, Robert Uy, John Zavadil
MG-112-A
http://www.rand.org/publications/MG/MG112

The Army cannot project power if it cannot get to where it needs to go to confront adversaries. The authors of this report developed scenarios and conducted political-military games to determine what strategies, tactics, and capabilities potential adversaries might use to prevent or complicate U.S. access to key areas and the effectiveness of the U.S. counters to these tactics. After their assessment, the authors were reasonably sanguine about the ability of the United States to prevail in the near term, but they also identified areas of future concern and suggested several improvements, including expanding the number of in-theater bases that might be available; enhancing the flexibility and deployability of U.S. forces to more austere bases; and upgrading detection, warning, and force protection measures.

Dollar Cost Banding: A New Algorithm for Computing Inventory Levels for Army SSAs

Ken Girardini, Arthur Lackey, Kristin Leuschner, Daniel A. Relles, Mark Totten, D.J. Blake
MG-128-A
http://www.rand.org/publications/MG/MG128

When Army equipment fails, how fast mechanics can fix it depends on the availability of needed spare parts. The Army wished to improve the algorithm used to compute the proper levels of inventory to stock in its repair shops. This monograph describes how the Army's Distribution Management Initiative (formerly known as Velocity Management) has been used to develop and implement a new algorithm for computing spare parts inventories maintained by Army supply support activities (SSAs), the element that provides spare parts to unit mechanics. The algorithm, known as dollar cost banding (DCB), has made it possible to increase the number of spare parts that SSAs take with them by adjusting the criteria for determining whether an item should be added or retained based on its cost, size, and the criticality of the demands. When setting the number and types of parts, DCB accounts for surges and variations in demand, thus making it more likely that a part will be available in the SSA when demands occur. The DCB algorithm has produced immediate and significant gains in performance at little or no additional inventory cost and without sacrificing mobility.

How Should the Army Use Contractors on the Battlefield? Assessing Comparative Risk in Sourcing Decisions

Frank Camm, Victoria A. Greenfield
MG-296-A
http://www.rand.org/publications/MG/MG296

This study proposes a method for comparing the "residual risks" of using military and contract sources to perform specific support activities on the battlefield. It applies the Army's standard approach to risk assessment, which identifies sources of risk or "threat," the risks they present, the opportunities available to mitigate these risks, and the risk that remains—the residual risk—when the Army chooses a particular course of action to mitigate risks. The approach considers choices of military and contract sources, with appropriate mitigation strategies, as alternative courses of action and compares the residual risks associated with each choice. The approach offers an orderly way to translate (1) the relative inherent capabilities of military and contract sources, the terms of applicable status-of-forces agreements, and the threats present at any particular place and time on the battlefield into (2) a comparison of the residual risks associated with military outcomes, the safety of contract personnel, resource costs, and other policy factors of greatest importance outside a particular contingency setting.

Increasing Participation in Army Continuing Education: eArmyU and Effects of Possible Program Changes

Bruce R. Orvis, Laurie L. McDonald, Barbara Raymond, Felicia Wu
MG-293-A
http://www.rand.org/publications/MG/MG293

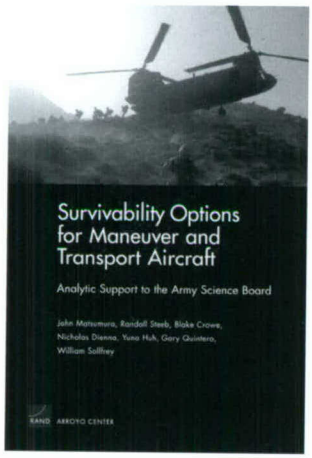
The eArmyU continuing education program allows enlisted soldiers to earn college credits while on active duty. This study sought to determine how to make eArmyU available to more individuals while controlling program costs. Historically, the primary cost of eArmyU had been attributed to the laptop computer provided through the program. This study examined the effects of the existing eArmyU program and of removing the laptop or other provisions on outcomes including soldiers' participation in the program, retention, duty performance, and quality of life. Four analytical approaches were used: a pilot test of alternative eArmyU programs, focus groups at pilot test sites, analysis of personnel records of enrollees and nonenrollees in eArmyU, and an educational interest and career plans survey of 8,000 enlisted soldiers. Those especially likely to enroll in eArmyU include: African Americans, females, AFQT Category I–IIIA soldiers, married soldiers, soldiers with dependents, and senior soldiers. The fully funded laptop is an important element underlying soldiers' participation in eArmyU; without it, eArmyU participation rates and the retention benefits of eArmyU are likely to decline significantly. Personnel records indicate that the current eArmyU program is associated with increased retention: eArmyU participants have one year longer to their expiration of term of service date than demographically similar nonparticipants, and 25 to 30 percent of participants extend or reenlist to participate. Study recommendations include ways to achieve the goals of increasing enlisted access to education opportunities, constraining eArmyU costs, and limiting soldiers' risk of recoupment.

Success of First-Term Soldiers: The Effects of Recruiting Practices and Recruit Characteristics

Richard J. Buddin
MG-262-A
http://www.rand.org/publications/MG/MG262

This monograph examines the relationship between recruiting practices and conditions and the first-term success of Army soldiers. Success in the first term is important to the Army because recruiting soldiers is expensive. If soldiers fail to complete their first terms, the Army must recruit others to replace them, effectively doubling the cost. Given the expense of recruiting, the Army should reassess whether some management strategies could improve the success rates for first-term soldiers. Events in a soldier's first term that show a statistically significant relation to early loss include length of time in the Delayed Entry Program, gender (women have consistently higher rates of attrition at each stage of the first enlistment), and education (soldiers without high school diplomas drop out at an increased rate beginning with advanced individual training). Attrition can also vary depending on the training installation, but high loss rates during basic training have no effect on subsequent attrition. Thus, it does not appear that applying higher standards in basic training reduces subsequent attrition in the enlistment cohort. All other things being equal, soldiers in combat arms have higher attrition rates than do those in other occupations. Finally, promotion

correlates positively with retention. Equally interesting are the influences that do not appear to make a major difference. These include participation in the Army College Fund, term of enlistment, the recruiting environment, and characteristics of recruiters. Recommendations include shorter time in the Delayed Entry Program for high school seniors, a revisiting of the fitness training unit concept, and imposition of consistent training standards and policies. The monograph also recommends exploring policies to help at-risk demographic groups such as women and recruits who hold GEDs, as well as a review of the promotion program to ensure that the most able soldiers are getting promoted.



Survivability Options for Maneuver and Transport Aircraft: Analytic Support to the Army Science Board

John Matsumura, Randall Steeb, Blake Crowe, Nicholas Dienna, Yuna Huh, Gary Quintero, William Solfrey
MG-123-A
http://www.rand.org/publications/MG/MG123

This monograph summarizes research in support of the 2002 Army Science Board's Aviation Study. The study explored and assessed survivability concepts and technologies associated with future heavy-lift transport aircraft that could be used to make possible new operational maneuver options for the Army's future force. The results of this research are included in the final briefing and report produced by the Army Science Board; this monograph provides a detailed account of the specific survivability research, and it includes information on scenario, methodology, and the analytic findings. Results show that operating transport aircraft in airspace that is defended by capable air defense systems is difficult and likely to result in at least some lost aircraft. Using layers of survivability techniques improves overall effectiveness and thus survivability. But the likelihood of lost aircraft means that the operational benefits must be weighed against the potential risk.

Transferring Army BRAC Lands Containing Unexploded Ordnance: Lessons Learned and Future Options

Jacqueline MacDonald, Debra Knopman, Noreen Clancy, Jimmie McEver, Henry Willis
MG-199-A
http://www.rand.org/publications/MG/MG199

In the ongoing Base Realignment and Closure (BRAC) process, lands containing unexploded ordnance (UXO) left over from military training have proved particularly difficult and costly to transfer to new users. With a few exceptions, little progress has been made in transferring these lands. This monograph chronicles the issues that facilitated the transfer of land containing UXO, and those that slowed the transfer. Some of the "facilitating" issues are low density of UXO, a small number of recipients, and strong financial incentives for the new user. Lack of regulatory involvement or oversight also helped facilitate transfer. On the other side, lack of knowledge about the location, quantities, and type of unexploded ordnance, inadequate performance of detection technologies, and an absence of accepted standards for cleanup all slowed transfers. The authors suggest an alternative organization for handling the transfer, in this case a federal government corporation, along with other mechanisms as ways to expedite the transfer of UXO-contaminated land.

A research brief is also available for this report: RB-9057-A, *Transferring Army Land Containing UXO: Problems and Possible Solutions.* http://www.rand.org/publications/RB/RB9057/

Urban Battle Command in the 21st Century

Russell W. Glenn, Gina Kingston
MG-181-A
http://www.rand.org/publications/MG/MG181

Urban areas are notorious for complicating operational planning, command, control, and the communications that facilitate the three. Buildings frequently interrupt the line of sight, interfering with radio and global positioning system signals. They often combine with extreme noise, dust, smoke, and light conditions to impede leader control at all echelons. The density of noncombatants and their potentially crucial influence on friendly force success further demand effective employment and synchronization of psychological operations, civil affairs, public affairs, and other resources. Savvy use of existent systems, employing decentralized control procedures, and innovation all have their place in overcoming these inherent limitations in the service of achieving objectives across the spectrum of conflict.

Urban Battle Fields of South Asia: Lessons Learned from Sri Lanka, India, and Pakistan

C. Christine Fair

MG-210-A

http://www.rand.org/publications/MG/MG210

This study examines several case studies of sustained campaigns of urban terrorism perpetrated by various domestic groups in the countries of India, Pakistan and Sri Lanka. One focus of this research addresses the modus operandi of the militant outfits. It describes the tactics they employ, their targeting means and objectives, and the ways in which these groups have innovated and evolved over time. This report illuminates, where possible, links that militant groups forge with other such organizations within South Asia and beyond. This work also examines the ways in which the three states respond to the menace of urban terrorism. It explains how each state mobilizes its security apparatuses (military, paramilitary, police), intelligence agencies as well as legislative and judicial bodies to counter the emerging threats. Finally, this research identifies key insights from these country-specific case studies that may inform U.S. stability operations in the cities of Afghanistan, Iraq, and elsewhere.

U.S. Army Security Cooperation: Toward Improved Planning and Management

Thomas S. Szayna, Adam Grissom, Jefferson P. Marquis, Thomas-Durell Young, Brian Rosen, Yuna Huh

MG-165-A

http://www.rand.org/publications/MG/MG165

In the realm of security cooperation—peacetime activities undertaken by the U.S. armed services with other armed forces and countries—the U.S. Army's current planning process is exceedingly complex, involving a multitude of actors, problematic incentive systems, an incomplete information exchange, and a lack of effective measures of effectiveness. Even some of the stakeholders understand only certain aspects of the process or have only partial visibility into it. Those who want and foster peacetime cooperative activities by the U.S. Army with other countries and militaries (Army International Affairs, or AIA) tend to have an incomplete understanding of the resourcing problems and the tradeoffs involved in making AIA choices. In turn, Headquarters, Department of the Army (HQDA)—the supplier of AIA resources—has an incomplete understanding of the benefits of AIA, and the Army's own resourcing tools do not make it easy to get an in-depth understanding of the resources it commits to AIA. The demand for AIA is driven by the amount of AIA supply provided by HQDA, as opposed to the latter being the product of policy, strategy, and resource guidance. Indeed, incrementalism and continuity, rather than policy and strategy, are the principal driving agents in the development of AIA resource priorities. In the post-September 11 security environment, the planning system of AIA needs greater flexibility and efficiency as a crucial component of the global war on terrorism. The need to have flexibility and adaptability in security cooperation, and to seize opportunities that may be short-lived, has made reform of the security cooperation planning and implementation process essential.

Value Recovery from the Reverse Logistics Pipeline

David Diener, Eric Peltz, Art Lackey, Darlene J. Blake, Karthik Vaidyanathan

MG-238-A

http://www.rand.org/publications/MG/MG238

Value recovery, in the form of the return and repair of spare parts that can be fixed, involves large amounts of time as well as inventory investment for the Army. Sometimes it is cheaper to buy a new part rather than fix it, but some parts are so expensive that it makes economic sense to repair them and return them to the inventory, typically as spares to replace other broken parts. This monograph reports on metrics developed to evaluate the retrograde processes and establishes a performance baseline in fiscal year 2000. The data collected indicated the presence of long repair times: over a month for items repaired below depot and returned to stock. It took an average of 82 days to move an item to depot for repair. These data suggest that the process has substantial potential for improvement. The authors suggest ways to speed up the movement of parts through the system to minimize the size of the parts inventory.

A research brief is also available for this report: RB-9091-A, *Getting Value from the Reverse Logistics Pipeline*. http://www.rand.org/publications/RB/RB9091/

The Weapons Mix Problem: A Math Model to Quantify the Effects of Internetting of Fires to the Future Force

Christopher G. Pernin, Louis R. Moore
TR-170-A
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For the Army's future force, what is the appropriate mix of weapons to provide a given outcome, and how might these weapons be employed? This research offers some initial observations into the internetting of fires (IOF) process and a foundation for understanding its relationship to combat outcome. IOF is "the ability to engage a particular target using any number of potential firers who are able to engage due to being on the network which provides targeting information." A key problem with implementing the IOF concept is to determine how to allocate fires among a collection of shooters on a network. The authors describe and demonstrate an analytic tool based on a mathematical optimization to determine that allocation. The authors also describe how the project sponsor used this tool to screen for good mixes of weapons, munitions, and sensors for the Army future force. ◆

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